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Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

Coal Research Laboratories

Laboratoires de recherche sur le charbon

Canada

AN OVERVIEW OF MICROPROCESSOR DEVICES IN RAILROAD, AUTOMOTIVE, SHIPPING AND AEROSPACE INDUSTRIES

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MICROMEDIA

AN OVERVIEW OF MICROPROCESSOR DEVICES IN RAILROAD, AUTOMOTIVE, SHIPPING AND AEROSPACE INDUSTRIES

by

H.G. Naidu*

ABSTRACT

High utilization of equipment is critical to the economics of modern mining operations. Inspite of good preventative maintenance practices, unpredicted breakdowns do occur which result in serious production losses and damage to equipment. To minimize such breakdowns, it is important to monitor the health status of equipment on a real time basis. CANMET is actively evaluating this technology with a view to identify the most suitable systems for surface mines.

In the current phase, the status of this technology in the non-mining industry has been reviewed. Different sources were contacted for this purpose including Transport Canada, NRC, CN and CP railways, and several instrument manufacturers both in Canada as well as in the U.S.A. An extensive display of the technical data gathered in the study is included in the appendices of this report.

The study has indicated that the non-mining industries are much more advanced in automating their operations. Several microprocessor based monitoring and control systems have potentials for their application in surface mines, for example, the vehicle identifier, equipment and repair crew dispatching, remote monitoring and energy management. Some of them e.g. computer aided crew and equipment dispatching, may be introduced in its present form whereas, others may require certain modifications. These systems will be studied in more detail in the future.

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APERCU DES DISPOSITIFS A MICROPROCESSEUR DANS LES INDUSTRIES FERROVIAIRE, AUTOMOBILE, MARITIME ET AÉROSPATIALE

par

H.G. Naidu*

RÉSUMÉ

La grande utilisation du matériel est un facteur critique dans l'économie des opérations minières modernes. En dépit des bonnes mesures d'entretien préventif, il se produit des pannes imprévues qui entraînent des baisses de production importantes et causent des dommages au matériel. Afin de réduire le plus possible ces pannes, il est important de surveiller l'état de fonctionnement du matériel en temps réel. A CANMET, on évalue activement les méthodes permettant d'effectuer une telle surveillance en vue de déterminer les systèmes qui conviennent le mieux dans les mines à ciel ouvert.

Dans la présente phase, on a examiné l'état des méthodes de ce type dans les secteurs autres que celui de l'exploitation minière. A cette fin, on a consulté plusieurs sources d'informations, notamment Transports Canada, le Canadien National et le Canadien Pacifique, ainsi que plusieurs fabricants d'instruments tant au Canada qu'aux États-Unis. Une présentation détaillée des données techniques recueillies au cours de l'étude est incluse dans les annexes du présent rapport.

L'étude a montré que les industries non minières sont beaucoup plus avancées en matière d'automatisation de leurs opérations. Plusieurs systèmes de surveillance et de commande à microprocesseur offrent des possibilités d'application dans les mines à ciel ouvert, par exemple l'identification du véhicule défectueux et la sélection du matériel et de l'équipe de réparation, la surveillance à distance et la gestion de l'énergie. Certains de ces systèmes, p. ex. les systèmes de sélection des équipes et du matériel assistée par ordinateur, peuvent être utilisés dans leur forme actuelle, tandis que d'autres peuvent nécessiter certaines modifications. On approfondira l'étude de ces systèmes dans le futur.

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INTRODUCTION

Microprocessor based devices are being increasingly used in various industries to enhance equipment utilization and control. They have also being used to maintain high safety and environmental standards. The railroad, aerospace, shipping and automotive industries have greater experience with these devices and it is believed that some of that technology may be transferable to surface coal and oilsands mining. For this reason, CANMET has initiated an in-house project in this area. As a first step, a review of the existing units designed for surface mine equipment was done followed by an industry survey designed to determine the industry acceptance of such devices. The reports generated in the two phases of work have already been circulated to the industries. The present work deals with the application and availability of electronic devices as used in the railroad, automotive, shipping and aerospace industries. Their posible application to coal and oilsands mines is also discussed.

MICROPROCESSOR BASED DEVICES USED IN NON - MINING INDUSTRIES

The sources contacted for obtaining information were:

- Transport Canada's:
  - Canadian Airspace group
  - Canadian Coast Guard
  - Canadian Surface Group (Rail and Road)
- National Defence
- Canadian National Railway
- Canadian Pacific Raiway
- National Research Council
- Instrument Manufacturers:
  - Texas Instruments
  - Leigh Instruments
  - General Railway Signal Co.(GRS)
  - Rockwell International
  - Union Switch and Signalling Div.

The status of monitoring and control devices as used or developed for various non - mining industries is to be described.

RAILROAD INDUSTRY

1. General Railway Signal Company (GRS):

This is one of the largest company in the United States which is actively involved in the manufacture and supply of microprocessor based monitoring and control devices for the transportation industry specially the railroads. Currently, several of their products are in use both in the U.S.A. as well as in Canada. The main features of the products are provided below. Detailed literature is given in Appendix-I:

(i) Automatic Vehicle Identifier System: the application of this system according to a company brochure is for:

- Locomotive tracking
- Train tracking
- Crew time monitoring
- Car reporting
  - Weigh scales (weigh-in-motion)
  - Hot box
  - Flat wheel
- Cab display systems
- Dark territory train management
- Dynamic data reporting from:
  - Locomotives
  - Refrigerator cars
  - End-of-train brake line pressure monitors
- Milepost reader systems for:
  - Geometry car
  - Locomotive performance analyzer
- Automatic route selection
- Locomotive refueling identification (fuel monitoring)
- Critical car tracking

(ii) Micro Traffic Master:

As described in the folder 262 of Appendix-I, "It is a centralized traffic control system using GRS GENERALOGIC microprocessors to perform all office logic functions". The unit is compact and all solid state system which the dispatchers can operate easily.

It consists of human-engineered consoles, simplified keyboards and aluminum track display panels representing the controlled territory. It can be linked to other computers for automatic dispatch and reporting systems. It also has diagonostic indicators which reduces maintenance work.

(iii) The Automatic train and traffic control system:

As described in the company's brochure(Appendix-I):

"The train and traffic control system consists of three major subsystems:

automatic train operation (ATO)
automatic train protection (ATP)
automatic line supervision (ALS)

Each subsystem operates independently and the entire operation is co-ordinated and monitored by central control.

The ATO system regulates train speeds between stations and provides automatic station stopping. While the ATP subsystem ensures proper train separation and safe movement through interlockings, ALS initiates routes through switches automatically, dispatches trains automatically and makes trains responsive to supervisor commands from central control. ALS communication between the train and wayside is via a GRS train-to-wayside communication (TWC) system.

The central control facility serves primarily to monitor the total transit system and to provide automatic dispatching. Corrective strategies are initiated manually.

The ATC system includes a data-transmission system (DTS) to transfer commands and indications between wayside facilities and central control".

(iv) "CABMATIC":

These are compact cab signal and speed control systems, designed for

use on locomotives, cab cars and rail transit cars. There are two types of systems available: one uses high frequency track circuits and the other uses power frequency track circuits (Appendix-I).

(v) Classification Yard:

CP Rail's Toronto Yard is a typical example. The system provides features like receiving-sorting-dispatching cars, measuring the speed, weighing the cars when in motion etc.

(vi) Automated Crew Dispatching System:

As described in the brochure in Appendix-I:

"This technology has converted the labour intensive task of crew dispatching into a computer-aided application. It hooks up the crew dispatcher and the computer to provide foolproof crew selection and notification system. The system also automatically updates employee availability, determines time worked, and computes wages; all on real-time basis, without the massive paper load of conventioal procedures".

(vii) SPACERAIL:

As described in folder 298 (Appendix-I):

"It is a vital location, communication and control system that:

- Locates trains using proven GRS IDENTIFIER technology,
- Provides vital communications links between control office, trains, and field equipment using proven, vital microprocessor technology,
- Increases the dispatcher's span of control from the central office,
- Displays signals in the cab".

(viii) SAFETY ASSURANCE LOGIC:

As described in folder 278 (Appendix-I):

"Safety Assurance Logic is the trademark for failsafe microprocessor-based equipment design, using a single processor with two logic systems incorporated in each program. The primary logic performs the basic function (e.g., generating a vital time interval), while the Safety Assurance Logic monitors the performance of the primary logic and does not allow an output to be delivered if the performance is incorrect".

(ix) SPEEDMASTER:

GRS has designed "SPEEDMASTER" to meet the needs of the high-speed passenger train corridor. As described in folder 278 (Appendix-I), it's capability include:

- Safety Assurannce Logic: described earlier, it is included in:
  Vital Processor Interlocking,
  Trakode II,
  Cabamatic 410,
  Compound vital message system,
  Michrochron Timer,
  Solid state microprocessor-based code transmitter.
- Wayside Oriented Moving Block,
- Automatic Dispatching,
- Datatrain Control and Telemetry System,
- Generalogic Microprocessors,
- Identifier - Automatic Vehicle Identification,
- Brake Assurance Subsystem.

2. ROCKWELL INTERNATIONAL:

The Rockwell International company has designed the "Advanced Railroad Electronics System (ARES)" for the railways. This system has the capability for real-time communications and accurate command and control of railroad units. As described in the company's brochures (Appendix-I):

"ARES consists of the following integrated systems:

- Data Management System,
- Rail Operations Control System,
- Locomotive Analysis and reporting System,
- On-board Display System,
- Energy Management System,
- Wayside Interface System.

Data Management System: It is considered to be the heart of ARES. This system receives, routes and delivers digital messages among the various ARES and railroad system components. It has three basic elements:

- Network controllers; that manage ARES communications through a wayside distribution network,

- Ground terminal controllers; that provide for VHF communications within about a 30-mile radius, and
- Data management units; which manage VHF communications on-board locomotives and other vehicles.

Rail Operations Control System: It is an advanced control and dispatching system that generates orders, monitors safety, determines compliance, optimizes traffic flow, and assists the dispatcher in making control decisions".

Locomotive Analysis and Reporting System: As described in the brochure (Appendix-I):

"It is a computer based capability that combines information from sensors and discrete inputs to:

- Monitor and report serious locomotive failures,
- Monitor locomotive performance and report substandard performance
- Monitor and report fuel quantity and history,
- Provide diagonostic data for on-board systems".

On-Board Display System: It is a train situation indicator (TSI). It displays necessary train operating information to the engineer e.g, train status, commands, locomotive throttle and brake settings. It utilizes user-friendly concepts of display and easily understood control inputs (Appendix-I).

Train Location System: As described in the brochure (Appendix-I), "This system determines via an on-board receiver highly precise train location and speed from in-track transponder devices and/or signals from multiple Navstar sattellites".

Energy Management System: This system evaluates all the available real-time operating data and determines the amount of energy required to meet the schedule resulting in reduced costs, increased safety and improved train handling.

Wayside Interface System: this system interfaces between the Data Management System and the railroad's existing wayside devices (Appendix-I).

3. Union Switch and Signalling Division (USS):

This company provides high technology control and signalling systems to the railways. Recently, this company has been bought out by an Italian company called "ANSALDO". Some information on two of their systems are as follows:

- "MYTAB": it consists of event recorders, data management and a control head; the events include locomotive speed, location, brake position etc.; this system is being used by New Jersey Transit,
- "LCAM": it is a locomotive control and monitoring system; CP rail is actively considering this system under their total integral train control system.

The Canadian National Railway utilizes "TRACK" system for the main lines and "YIS" system for the rail yards. The electronic devices are obtained from the above manufacturers (GRS, USS).

AUTOMOTIVE INDUSTRY

1. General Railway Signal Company (GRS): company's brochure is given in Appendix - II:

(i) GRS Transit Master: it is a system for fleet management, communication and control; the features include (see Appendix-II):

- Vehicle location,
- Radio communication between vehicles and the central control centre,
- Efficient scheduling of routes, and
- Emergency communication network for transit police, or other services.

(ii) Data Collection System:

As described in the company's brochure (Appendix-II), this system records the following information and sends it to the central control centre for management use:

- Passenger counting,
- Vehicle location,
- Farebox data,
- Mechanical alarms,
- Emergency alarms and,

- Routing information.

SHIPPING INDUSTRY

Leigh Instruments Limited:

The Canadian Coast Guard utilizes remote monitoring systems (RMS) for the management of their vessel traffic. The control and monitoring units have been supplied by Leigh Instruments Limited.

This company has supplied a sophisticated communication system to Canadian navy called shipboard integrated interior communications system (SHINCOM).

Remote Monitoring System:

As described in the manual(Appendix-III):

"this system consists of equipment which enables the operations centre personnel to control and monitor remote radar and video transmission equipment and to receive alarms from video and message transmission equipments and certain remote and local facilities.

Shipboard Integrated Interior Communications System:

As described in the report of Leigh Instruments (Appendix-III):

"SHINCOM is a sophisticated and secure militarized telephone exchange. It enables communication within the warship and access to the external environment. Using all digital switching technology, it provides the security, speed, reliability and survivability of voice communications that are so essential to the operation of a modern ship". Details are provided in the report (Appendix-III).

AIRSPACE INDUSTRY

Air Traffic Services Organization:

As per report TP4334 Of Transport Canada, "Canada's Air Traffic Services (ATS) organization is functionally responsible for providing air traffic control and advisory services in the airspace overlying Canada and in international airspace for a major portion of the North Atlantic".

The Canadian Air Navigation Services (ANS) has embarked on a major plan called "Maintenance 2000". The objective is to utilize remote maintenance and monitoring (RMM) and automated maintenance management (MM). As described in the report TP 8537 (Appendix-IV), "In the Maintenance 2000, environment, the maintenance workforce will be concentrated in maintenance centres responsible for the maintenance of electronics systems/equipment in a defined geographic area. They will perform the majority of their duties from the maintenance centre using the RMM as their principal tool and test instrument. Critical parameters will be monitored electronically and fed to the maintenance centre. If a fault occurs, qualified personnel will carry out remote diagonostics and systems analysis, isolating the problem to the lowest replaceable module. The RMM will be tailored for easy and efficient access by its users and will interface with each ANS system and non-ANS system as required". The details of this system are provided in (Appendix-IV).

Supervisory Control and Data Aquisition (SCADA)S/3:

It is a system designed by Texas Instruments. As described in their Document number SD2.0001 (Appendix-IV):

> "It is an integrated, state-of-the-art, computer-based supervisory control and information system. It provides console operators and other personnel the capability to monitor and control network operations in real-time. The S/3 SCADA system is functionally divided into three major areas of responsibility:
> - Aquisition of device status and data from field devices at remote sites,
> - Processing of the data required to monitor operations and presenting the data to console operators in a timely manner,
> - Transmitting console operator-initiated control commands to the remote sites for device controlling".

Microwave Landing System (MLS):

At the present time instrument landing systems (ILS) are in use at most of the airports for two-way communication between the aircrafts and the ground control stations and for guiding the aircrafts to land. A new precision system called microwave landing system (MLS) has been developed by

Micronav Limited based in Sydney, Nova Scotia which is currently under test in Canada. This system is fully automatic and can be monitored from a central location. It is very useful specially for remote locations for guiding aircrafts to land. One such system is currently operating at Lloydminister, Alberta, and is being monitored from Edmonton. This system has also been installed at the Port Havkesbury, Nova Scotia and Pemberton, British Columbia.

Tactical Air Navigation Beacon System (TACAN):

This system is developed by Leigh Instruments. As described in their report (Appendix-IV):

> "The system provides navigation data to en-route or terminal aircraft that are within a 250 nautical miles range of the beacon. The TACAN system responds to an interrogation signal from any suitably equipped aircraft. It sends back information from which the aircraft calculates its range and bearing with respect to the beacon. This system is available for in land-based, shipborne and mobile variants".

Distance Measuring Equipment:

This system provides an interrogating aircraft with its distance from a fixed base thereby assists in the landing of aircraft. It is planned to integrate this unit with MLS at the site.

Other Systems under test in Canada:

1. Mobile Equipment Monitoring System (Smart Operator):

This system has been designed by Advanced Electronics Systems limited (AES) for heavy duty mobile equipment. One such unit has been recently tested at one of the INCO's mine on a Load-Haul-Dump (LHD) unit.

The system consists of 72 sensors located at different points on the the loader to monitor pressure, fluid levels, temperatures, gear position, voltages, currents and several other items related to the health and performance of the loader (1). As described by Baiden, 1988, "This information will be fed to an on-board computer for data compaction and limited operator diagnostics followed by transmission to a base station

computer for further analysis. The base station computer will allow the maintenance professional to diagnose potential problems with the aid of an 'Expert System'. As well, a permanent historical log can be developed for each machine and operator".

Recently, this system has been installed on logging trucks at Port Alberny, B.C. These tests are expected to provide information on the adequacy and reliability of the system. The details of this system is provided in Appendix-V.

2. Ropec System:

The Ropec Industries Inc. of Vancouver, B.C, have designed a system called "Ropec". It is an electronic unit which monitors the vital signs of the engine and displays on a screen (in the operator's cabin) the possible cause of a malfunction. In case the malfunction persists, it initiates the orderly and safe shutdown of the engine (2). This system is installed on off-highway trucks at Smoky River mine and is operating satisfactorily (Srajer, 1988).

DISCUSSION

It is recognized in most of the industries that equipment health and performance monitoring is a pre-requisite to optimization of their total performance. Health monitoring with advanced warning systems could prevent major breakdowns, loss of productive hours and contribute to safety of equipment and operators.

This study has clearly shown that the utilization and technology of electronic devices for equipment monitoring and control is more advanced in the railroad, automotive, shipping and aerospace industries. It is considered that some of this technology can be gainfully used in the Canadian surface mines. At this stage, it is however not possible to identify all the systems which could be introduced into the surface mines with concomitant benefits. This will be done in the second phase of the study to begin immediately. However, the systems considered to shov a potential are:

- Automatic Vehicle Identifier System of GRS,

- Supervisory Control and Data Aquisition System of Texas Instruments
- Remote Monitoring and Maintenance System of Leigh Instruments,
- Advanced Railroad Electronics System of Rockwell International,

All the four systems are designed to accomplish similar objectives. What is needed is to evaluate them individually including any other system/devices that may become known via future work, and assess which system could be introduced in surface mines with least modifications and can withstand the harsh mine environment.

The three basic elements required in a system for surface mines are:

- on-board device for monitoring equipment diagonostics and with advance warning capability,
- Data gathering and transmission to central control center,
- Central control centre for data aquisition, processing and transmission of commands back to the on-board systems for execution. Additionally, it should have the capability of producing equipment diagonostics and performance reports.

All the above three should be fully automatic with override control to be used in alarm conditions. The control centre should have the capability for automatic dispatching of equipment as well as dispatching of crews for equipment repairs. In addition, there should be a system for monitoring of these units to ensure that at all times they are in a perfect running order. This study has shown that similar systems are in use at non-mining industries.

The facility of weighing loaded trucks while in motion is another area where productivity improvement in surface mines is possible.

Energy Management System (a part of ARES) used in the railroad industry to analyze equipment performance in relation to energy consumed, appears to be another system which could be used by the mining industry.

In the next phase of work, it is intended to concentrate on the needs of mobile mining equipment only. With this objective, the instrument manufacturers with proven devices for equipment health and performance monitoring systems, will be visited to discuss and assess their potential application to Canadian surface mines.

CONCLUSIONS

The Coal and Oilsands surface mines are in need of reliable microprocessor based monitoring and control systems for optimizing overall mine performance. This study has shown that such systems are available and currently in use in other industries.

In the second phase of this work which will begin immediately, instrument manufacturers and users will be visited to discuss the developments in greater detail and to identify those which might have an application in mining with modifications or otherwise.

ACKNOWLEDGEMENT

The author would like to thank the staff of Transport Canada, National Defence, National Research Council, Leigh Instruments Co., Texas Instruments, GRS, Rockwell International and Union Switch and signalling Division for providing information in preparing this report.

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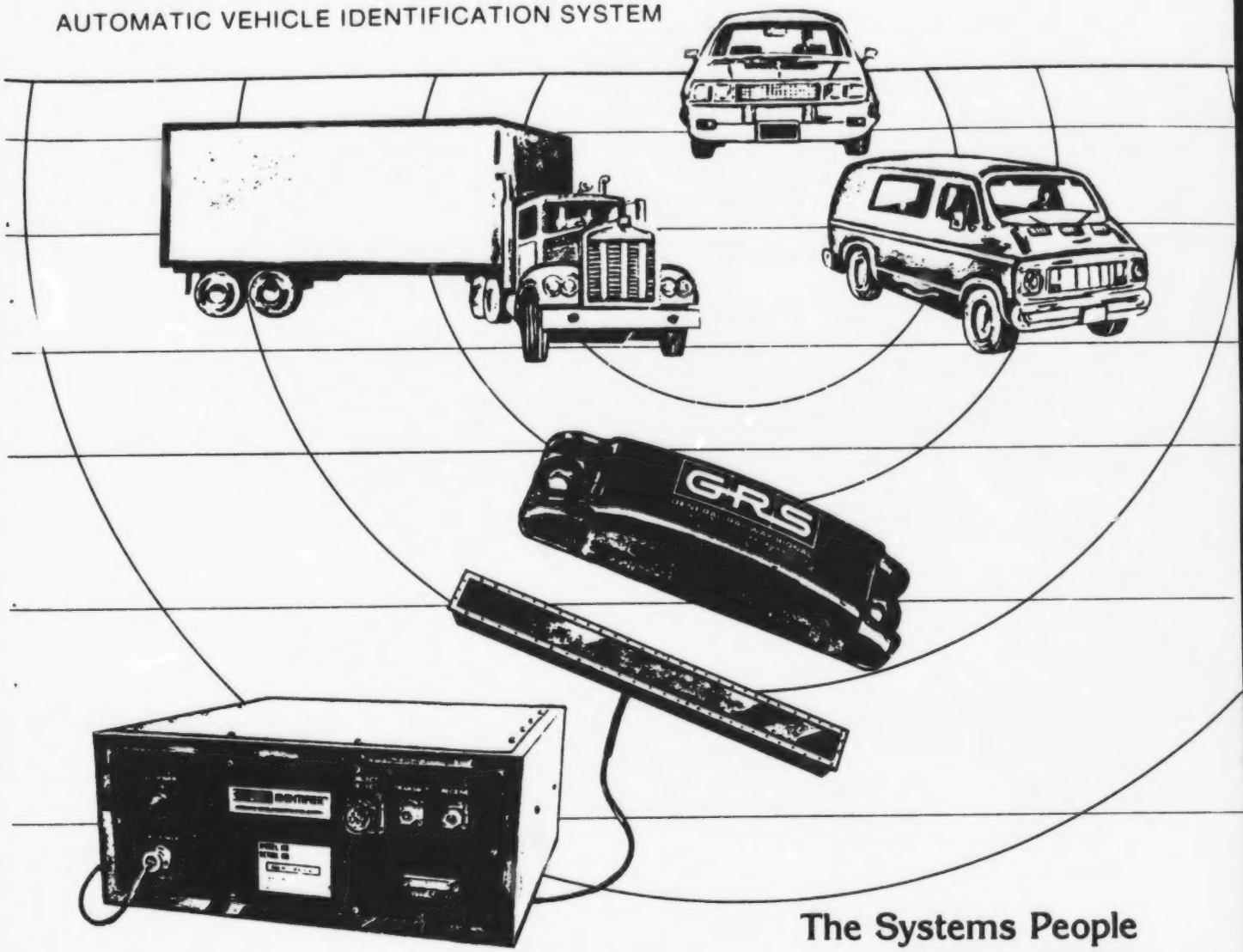
2. Srajer, V, "Equipment Monitoring at Smoky River coal mine: Trip Report", 1988.

APPENDIX - I: Electronics in Railroad Industry

GENERAL RAILWAY SIGNAL

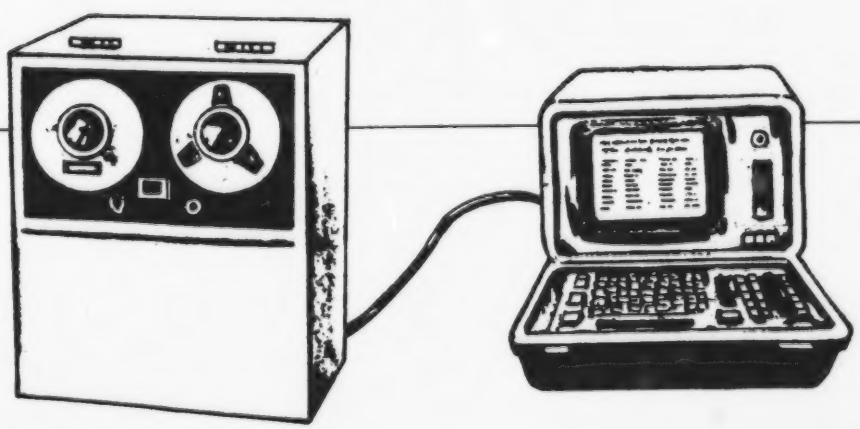
IDENTIFIER®

AUTOMATIC VEHICLE IDENTIFICATION SYSTEM



The Systems People

GRS



AUTOMATIC VEHICLE IDENTIFICATION INFORMATION SYSTEMS FOR TRANSPORTATION MANAGEMENT AND CONTROL.

THE COMPETITIVE EDGE:

Today's transportation companies use highly sophisticated data management systems to help increase operational efficiency. But, too often, the weak link in the information chain is the lack of enough accurate, real-time operating information to make these systems really pay off, and give their users the competitive edge they need.

Now, GRS IDENTIFIER® Systems can provide the accurate, real-time operating information the transportation industry has been looking for!:

IDENTIFIER Systems replace yesterday's manual data entry and operation with tomorrow's state-of-the-art automated technology today.

IDENTIFIER Systems provide automatic data gathering and input capabilities for literally hundreds of different transportation management applications; from tracking vehicles and containers to vehicle identification.

For example, an IDENTIFIER System can:

- Identify the presence of vehicles.
- Describe the identified vehicle (e.g., NTX Tractor 271 Buffalo, N.Y. 9/11/85 14:05 Depart)
- Record and report vehicle description, along with time, date, and direction of travel.
- Control various system actions (e.g., access gates, security alarms, dock/parking lot assignment).

IDENTIFIER Systems interface easily with existing communications and data management systems.

The state-of-the-art IDENTIFIER technology is cost effective, versatile, rugged, and reliable. Systems are easy-to-configure and easy-to-install. And IDENTIFIER has been proven on trains, trucks, and transit vehicles, at speeds to 120 mph, with demonstrated accuracy of 99.9%.

IDENTIFIER Systems can tell you:

Where your vehicles are. Where they are headed. What's inside. When they leave and when they arrive. And just about anything else you need to know.

What can you do with this kind of accurate, real-time information?

Better vehicle use makes you more competitive.

Increased service efficiency and traffic volumes generate more profits.

And the improvements in operating efficiency guarantee a fast payback and a satisfactory return on investment.

Best of all, the GRS IDENTIFIER technology is available in a variety of complete, fully developed systems; proven in truck, automobile, intermodal, and railroad applications; ready to give you the competitive edge—today!

IDENTIFIER

THE SUPERIOR TECHNOLOGY FOR TODAY, AND TOMORROW.

The state-of-the-art IDENTIFIER technology offers the optimum solution to the demands of automatic vehicle identification, for today and tomorrow.

The GRS ultra high-frequency technology uses short wave lengths and focused signals, allowing the use of small, easy-to-attach, passive identification Tags. The associated Readers and Antennas are also compact and easy to install.

The IDENTIFIER signal is not affected by rain, snow, dirt, or electromagnetic interference; Tags require no cleaning, maintenance, or batteries; and the rugged, reliable design is impervious to vibration, shock, and climatic extremes.

The IDENTIFIER uses a high scanning rate to check and recheck transmitted data, virtually eliminating undetected errors. Mean time between the component failure is projected at 75 years.

What's missing?

Only the endless cleaning and maintenance involved with optical identification systems. The bulky antennas and batteries required by some low frequency loop systems. The complex networks involved with LORAN and similar systems. And the labor costs and human errors associated with manual observation and data entry.

A complete Product Line for all Transportation Identification Needs:

Some identification systems are designed only for railroad use, others only for truck applications, still others only for personnel identification.

The GRS IDENTIFIER technology has been designed with the needs of the total transportation industry in mind, and has been demonstrated in highway, intermodal, container, rail, and personnel identification applications.

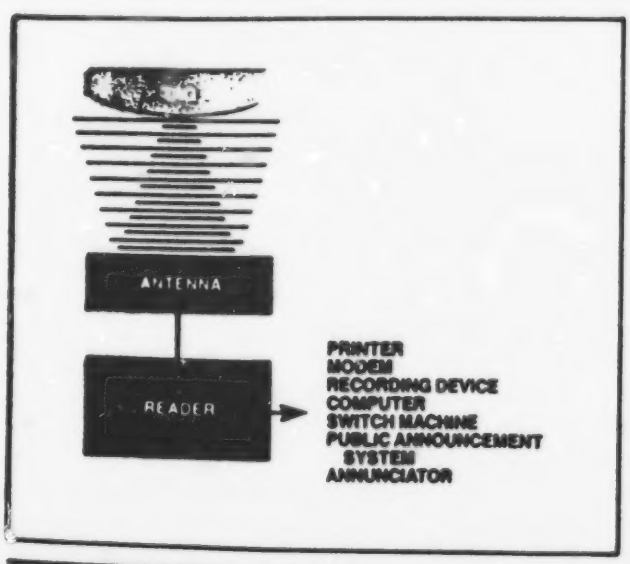
Most important, the GRS IDENTIFIER technology has been designed to work for you:

The system offers a variety of Tag, Reader, and Antenna configurations to match any application. Readers can provide standard reports, or format reports to your specifications. A portable tag-programming unit allows the flexibility of field-programming your own Tags. And standard interfaces and communications protocol assure total compatibility with your current data communications and management systems, as well as any systems you might install in the future.

With IDENTIFIER, you get the trouble-free, practical, and versatile automatic vehicle identification you need to increase operating efficiency, customer service, and profits.

THE IDENTIFIER SYSTEM AT WORK

The GRS IDENTIFIER system is designed for multiple applications in the transportation industry, using easy-to-install elements that can be arranged in various configurations to exchange identifying information between moving locations and wayside locations. A roadside reader can question the identity of Tag-equipped vehicles moving past the location. Or, the Reader can be vehicle mounted to question wayside-located tags, in applications like directing vehicles to terminal parking locations.



IDENTIFIER Operation.

The IDENTIFIER Reader transmits a low-powered RF signal from the Antenna toward a target location. When a Tag enters the target location, it absorbs enough energy to return a low-level signal toward the Reader indicating its presence. The Reader responds with a high level of RF signal. The Tag then uses this additional energy to return a coded signal to the Reader Station, identifying itself and its location.

This signal is decoded by the Reader and can be stored, printed out, or forwarded immediately to a host computer or any type of logging device.

The complete identification process takes less than 100 milliseconds, and involves built-in error checks to assure accuracy.

IDENTIFIER Readers can be operated in a "sniff" mode, constantly seeking a signal, or can be turned on and off with an external presence detection device.

Basic Elements.

The basic elements of the IDENTIFIER System are the IDENTIFIER Reader, its accompanying Antenna, and the IDENTIFIER Tag.

Readers and Tags can be fixed or portable, and mounted on vehicle or wayside locations at scanning distances to 75 feet.

The IDENTIFIER Reader.

The IDENTIFIER Reader is a microprocessor-based unit that sends an RF signal to the Tag, via a transmitting antenna. The coded message returned by the Tag is decoded by the Reader and passed on to a Host/Recorder device. Information can be stored, printed out directly, or transmitted immediately.

The Reader can interface with a host computer, either directly or through a modem, with appropriate protocol conversion as required, using a serial ASCII output signal; or, directly to a printer or other logging device. In either case, an IDENTIFIER Communications Board may be used to format and/or store the data for later retrieval.

The Reader is supplied with appropriate housing and power supply for roadside case, cabinet, or vehicle mounted applications.

IDENTIFIER Reader options include:

The IDENTIFIER Communications Board. The optional IDENTIFIER Communications Board receives

information from the Readers, then outputs a formatted message that includes: location, date, time, antenna number, and direction of travel.

The Communications Board is equipped with a Line Driver/Modem. It can accommodate up to 200 identities, and will also handle input from other detectors or sensors (speed detectors, weight sensors, temperature sensors, etc.).

Optional Antenna Controller Module. Adds to the versatility of the system by directing the Reader to identify and read through up to six different antenna systems. A multiplexer allows one Reader to read up to six antennas, and comes with the optional antenna controller and modem. This unit can also be used to control traffic lights, gates, and similar devices through six software controllable relays.

IDENTIFIER Field Programming Unit. The Field Programming Unit allows you to permanently code the Fixed Tag with the desired 12-character code, in a field location.

The IDENTIFIER Tag.

The IDENTIFIER Tag is built around a sophisticated, proprietary LSI code chip that is reliable at extremely low power levels. The Tag is permanently coded to meet specific applications with up to 12 alphanumeric characters. The Tag can be coded at the factory or in the field.

Tags are packaged in tough polycarbonate cases that offer high impact resistance, and are impervious to vibration, shock, dirt, dust, rain, snow, and climatic extremes. A high temperature version is available for temperature ranges up to 375°F.

The Tags are compact and completely passive. No internal batteries or outside power sources are required. They mount quickly and easily almost anywhere. And the same Reader will read all types of IDENTIFIER Tags.

Hand-Held Identification Tag. This is a smaller version of the vehicle mounted tag that can be carried in a shirt pocket or clipped to the visor of a car. It is used in personnel identification and parking lot access and control applications.

IDENTIFIER Antenna.

IDENTIFIER Antenna Systems are housed in weather-protected enclosures that can be located up to 100 feet from the Reader. Different antenna sizes and configurations are supplied to meet different applications. Long range (5′ to 30′) and short range (0′ to 8′) antennas can be installed overhead or at vehicle-side locations. The new "in-pavement" advanced technology antenna provides a coverage area from zero to six feet high, and up to sixty feet wide (with six 10′ in-pavement antennas).

IDENTIFIER APPLICATIONS:

GRS IDENTIFIER Systems can be configured to track vehicles, control operations, and monitor on-board conditions. They offer immediate benefits today, and they are designed to meet the automatic vehicle identification needs of the future.

Recording and reporting is compatible with almost any interface, so networking systems can range from simple Reader-Terminal hardwired connections to multi-line mainframe systems.

The same technology and components are used in all applications, so a single system can be readily expanded to meet new or multiple applications.

Typical IDENTIFIER System applications include:

Vehicle Management. IDENTIFIER Systems identify and track vehicles for more efficient dispatching, maintenance scheduling, refueling, trip recording, etc. And, they can provide fast, accurate response to shipper or consignee questions.

Terminal Applications. By recording the passage of vehicles and containers at terminals and other selected points, the System can be used to log vehicles in and out of terminals; to identify and monitor trailers, containers, tractors, and bogies, etc.; to direct traffic to docks or to parking and staging areas; as well as in a variety of intermodal applications.

Weighing Applications. The use of IDENTIFIER Systems at weigh-in-motion scales saves waiting in line and is more accurate than manual data entry.

The system is also faster and more accurate than manual data entry in static weighing and mining applications.

Lading Monitors. IDENTIFIER Systems can be used to monitor and report internal lading pressures, temperatures, trailer fuel levels, etc.

Personnel and Access Control Applications. IDENTIFIER Personnel Identification Systems can be used in a variety of security and access control applica-

tions; e.g., military, government, industry, banks, hospitals and universities, etc.

Fleet and Company Car Control. More effective and efficient fleet and company car control can be obtained by using an IDENTIFIER System to log vehicles in and out.

Parking Control. IDENTIFIER Systems can be configured in a number of different ways to provide parking control for corporate, municipal, private, or commuter parking situations.

Toll/Express Lane Control. IDENTIFIER Systems can monitor passage of specific vehicles in and out of toll stations, in regular or express lanes. The information is then used for billing, chargeback, or other calculations.

Combining Applications for Fast Payback and Maximum Return on Investment.

IDENTIFIER Systems can save you money now, and in the future because the technology is so versatile that common equipment can be used in a variety of applications.

This means the user can add applications to a basic system, thus speeding payback and increasing return on investment.

Some examples:

Trailer Tags that tie in with state operated highway scales can also be used to track trailers in and out of terminal facilities.

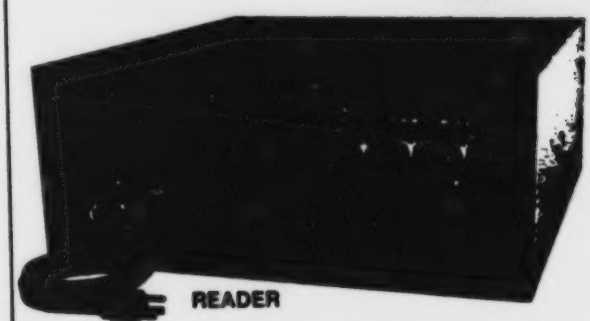
Readers reporting vehicle movements in and out of terminals can also read vehicle movements in other locations; e.g., shops or customer docks.

Readers that report vehicle passage can also be used to report fuel levels, refrigerator temperatures, and other dynamic data.

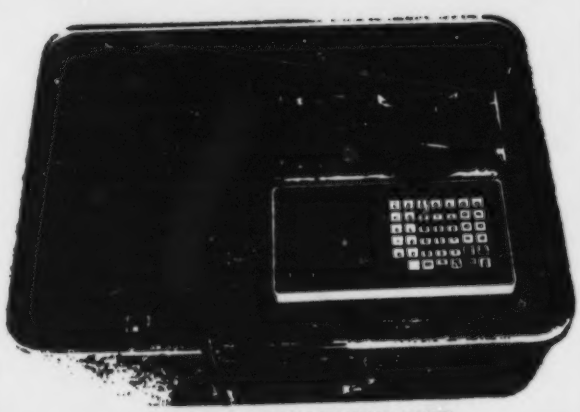
Best of all, the IDENTIFIER technology is NOT exclusive. It will integrate easily with any other information gathering and reporting technology, today or in the future.

TAG

HAND-HELD TAG



READER



FIELD PROGRAMMING UNIT

GRS IDENTIFIER® SYSTEMS

Automatic Vehicle Identification
Information Systems for Transportation
Management and Control.

The Competitive Edge:

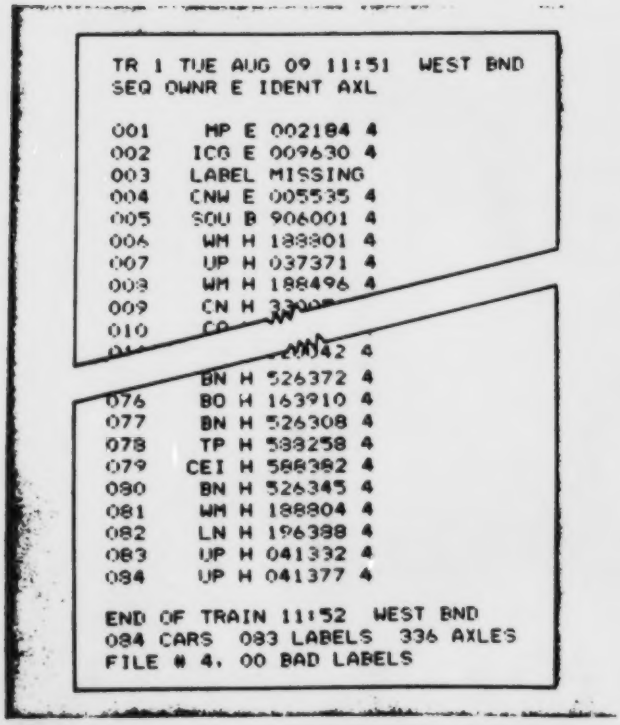
Today's transportation companies use highly sophisticated data management systems to help increase operational efficiency. But, all too often, the weak link in the information chain is the lack of accurate, real-time operating information necessary to make these systems really pay off; and give their users the competitive edge they are looking for.

Now, GRS IDENTIFIER Systems can provide the accurate, real-time operating information the transportation industry has been looking for!

The IDENTIFIER replaces yesterday's manual data entry and operation with tomorrow's state-of-the-art automated technology.

IDENTIFIER provides automatic data gathering and input capabilities for literally hundreds of different transportation management applications; tracking vehicles, monitoring on-board conditions, and assisting in controlling operations.

IDENTIFIER interfaces easily with existing communications and data management systems.



The state-of-the-art IDENTIFIER technology is cost-effective, versatile, rugged, and reliable. Systems are easy-to-configure and easy-to-install. And IDENTIFIER has been proven on trains, trucks, and transit vehicles; at speeds to 120 mph, with demonstrated accuracy of 99.91%!

IDENTIFIER Systems can tell you:

Where your vehicle is.
Where it is headed.
What's inside.
When it leaves and when it arrives.
And more.

What could you do with this kind of accurate, real-time information?

Better vehicle use makes you **more competitive.**

Better service means **more satisfied customers.**

Increased efficiency and traffic volumes generate **more profits.**

And the improvements in operating efficiency guarantee a fast payback and **exceptional return on investment.**

Best of all, the GRS IDENTIFIER technology has been proven in rail, transit, and intermodal applications; and is available, ready to give you the competitive edge—today!

IDENTIFIER

THE SUPERIOR TECHNOLOGY FOR TODAY, AND TOMORROW.

The state-of-the-art IDENTIFIER technology offers the optimum solution to the demands of automatic vehicle identification, for today and tomorrow.

The GRS ultra high-frequency technology uses short wave lengths and highly focused signals, allowing the use of small, rugged, easy-to-attach identification Tags. The associated Readers and Antennas are also compact and easy to install.

The IDENTIFIER signal is not affected by rain, snow, dirt, or electromagnetic interference; Tags require no cleaning or maintenance; and the rugged, reliable design is impervious to vibration, shock, and it works over the full AAR temperature range of $-40°$ to $+70°C$.

The IDENTIFIER uses a high scanning rate to check and recheck transmitted data, virtually eliminating errors.

What's missing?

Only the endless cleaning and maintenance involved with optical identification systems. The bulky antennas required by low frequency loop systems, and the batteries often needed by some tags. The complex networks involved with LORAN and other systems. And the labor costs and human errors associated with manual observation and data entry.

A Complete Product Line for all Transportation Identification Needs:

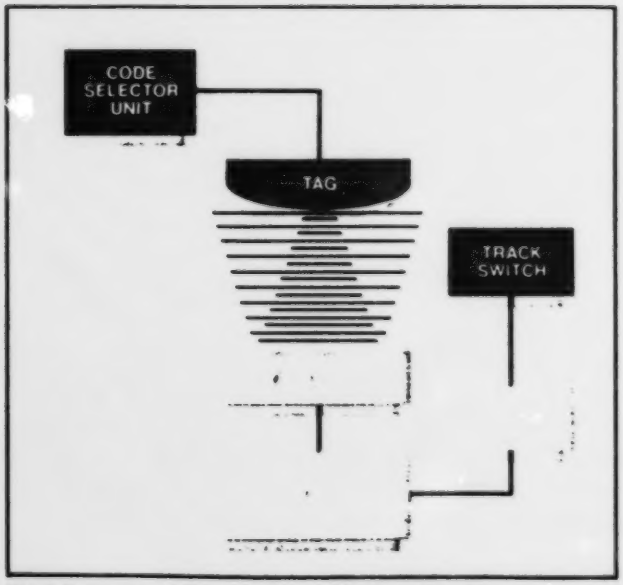
Some identification systems are designed only for railroad use, others only for truck applications, still others only for personnel identification.

The GRS IDENTIFIER technology has been designed with the needs of the total transportation industry in mind, and has been demonstrated in rail, highway, intermodal, container, and personnel identification applications.

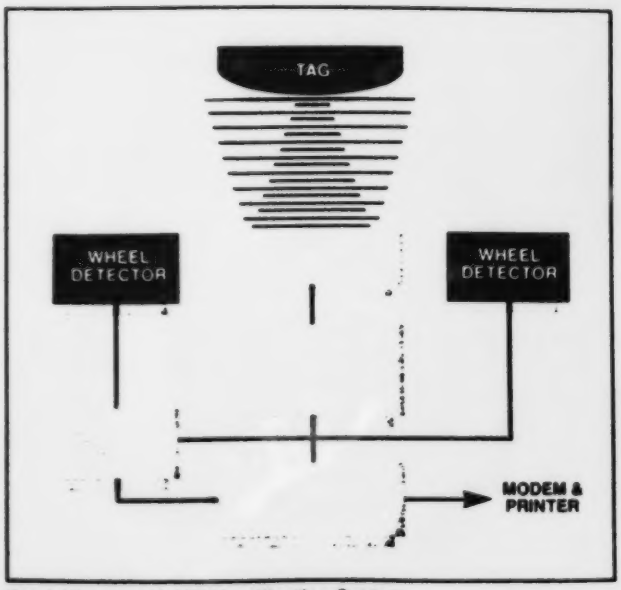
Most important, the GRS IDENTIFIER technology has been designed to work for you:

The system offers a variety of Tag, Reader Station, and Antenna configurations to match any application. Reader Stations can provide standard reports, or format reports to your specifications. A portable tag-programming unit allows the flexibility of field-programming your own Tags. And standard interfaces and communications protocol assure total compatibility with your current data communications and management systems, as well as any systems you might install in the future.

With IDENTIFIER, you get the trouble-free, practical, and versatile automatic vehicle identification you need to increase operating efficiency, customer service, and profits.



Block Diagram of Automatic Route Selection System



Block Diagram of ACI Identification System

THE IDENTIFIER SYSTEM AT WORK

The GRS IDENTIFIER System is designed for multiple applications in the transportation industry, using easy-to-install elements that can be arranged in various configurations to exchange identifying information between moving vehicles and wayside locations. Depending on the configuration, communication can be initiated from a moving vehicle or stationary location.

The system interfaces easily with a variety of external communications options, offering a high level of vehicle identification and control potential to the IDENTIFIER user.

For example, an IDENTIFIER System can:

Identify the presence of vehicles and/or wayside locations.

Describe the identified vehicle and/or wayside location (e.g., "Conrail Locomotive 6099...Milepost 734... Speed Restriction 2 mi. Ahead...etc.").

Record and report vehicle and/or wayside location and description, along with time, date, and direction of travel. Reports may be forwarded either instantaneously or when requested.

Initiate Control of various system actions (e.g., track switch position, train speed, etc.).

Provide alarms to alert train or work crews.

Announce trains approaching stations.

Basic Components.

The basic components of the IDENTIFIER System are the IDENTIFIER Reader Station, its accompanying Antenna, and the IDENTIFIER Tag.

The IDENTIFIER Tags are available in Fixed Code (standard, high-temperature, and personnel) and Data Tag (Variable Code). Fixed Code Tags transmit a constant message, while Data Tags are designed for dynamic data acquisition and can accept and transmit variable input.

The same Reader Stations and Antennas will read all three types of tags.

The IDENTIFIER Reader Tags and Reader Stations and Antennas operate in conjunction with a Host, or recording device, which records the information they provide. This Host can be anything from a simple keyboard printer to a large mainframe computer.

The Tags and Reader Stations and Antennas install easily in different configurations, to meet different applications. For example, a wayside Reader Station can question the identity of Tag-equipped vehicles up to 25 feet away moving past the location; or, the Reader Station can be vehicle-mounted to question wayside-located tags.

IDENTIFIER Operation.

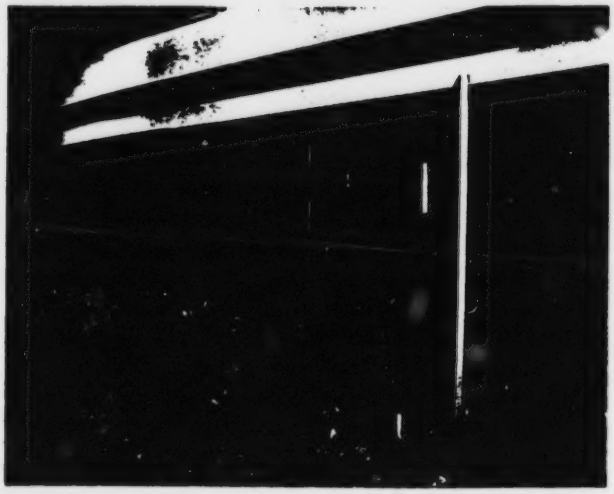
The IDENTIFIER Reader Station transmits a low-powered RF signal from the Antenna toward a target location. When a Tag enters the target location, it absorbs enough energy to return a low-level signal toward the Reader Station, indicating its presence. The Reader Station responds with a high level of RF signal. The Tag then uses this additional energy to return a coded signal to the Reader Station, identifying itself with its own unique identity.

This signal is decoded by the Reader Station and can be stored, displayed, printed out, or forwarded immediately to a host computer or any type of logging device.

The complete identification process takes only a few milliseconds, and includes built-in error checks to assure accuracy.

The IDENTIFIER System will interface with almost any communications or data processing system, existing or new. Typical interfaces include printers, modems, logging and recording devices, switch machine control circuits, digital sensors, and computers. It also includes the capability to accommodate a wide variety of data formats.

IDENTIFIER Reader Stations can be operated in a "sniff" mode, constantly seeking a signal, or can be turned on and off with a presence detection device, such as wheel detectors or track circuits.



IDENTIFIER APPLICATIONS:

GRS IDENTIFIER Systems provide the accurate and timely information necessary for effective transportation management and control.

Systems can be configured to:

TRACK vehicles.

CONTROL operations.

MONITOR on-board conditions.

And the same technology and components adapt to all applications, so a single system can be expanded to include different applications. IDENTIFIER can offer immediate benefits today. And it will meet the automatic vehicle identification needs of the future.

Vehicle/Location Tracking:

Reader-Tag systems are configured to identify specific vehicles or locations. Applications include:

Locomotive Management. Identifies and tracks locomotives for more efficient dispatching, maintenance scheduling, fueling, recording, etc.

Vehicle Tracking. Tracks hazardous or critical loads. Provides fast, accurate response to shipper or consignee questions.

Track Inspection. Automatically identifies and records key wayside locations to pinpoint track condition locations.

Crew Time Monitoring. Accurate, easy-to-obtain, and efficient.

Weigh-In-Motion Scales. More efficient than manual observation and data entry.

Train Information (dispatching) Systems:

With Tags on the front and rear of trains, and wayside Readers at appropriate locations, an IDENTIFIER System can provide the information required for train dispatching, and train control. Applications include:

Dark Territory Train Tracking. A low cost, non-vital tracking system for non-signaled railroad lines, operating on a "check-in/check-out" basis.

Automatic Route Selection. Switch positions are controlled based on inputs from Tags on approaching vehicles.

Arriving Station or On-Board Announcements. Announcements are activated by Tag/Reader interaction.

Cab Crew Alarms. Systems can be coded to observe vehicle conditions and activate necessary cab crew alarms.

Dynamic Data Acquisition:

IDENTIFIER Readers and Data Tags can be configured to acquire and report a variety of dynamic data regarding vehicle and on-board conditions. Applications include:

Locomotive Fuel Gauge Readings. Accurate monitoring can contribute to operational savings.

Lading Monitors. Measure and report internal lading pressures, temperatures, etc.

End-of-Train reporting. For applications requiring precise clearance information, and end-of-train brake line pressure data.

Intermodal Applications:

IDENTIFIER can identify and record the passage of vehicles and containers at terminals and other selected points. The system can be used to log vehicles in and out of terminals; to identify and monitor trailers, containers, tractors, locomotives, cars, trains, and bogies; even to track vehicles or special loads on the highway.

Train Management Information Systems (TRAIN II):

The IDENTIFIER System can be the basic information input device for a full scale Train Management Information System.

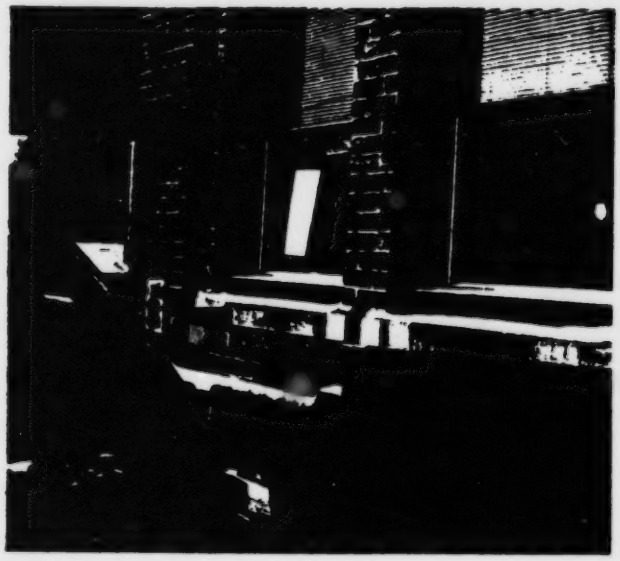
It is capable of providing information on any level of operation on any given portion of the railroad, and constantly updating this information on a real-time basis. Selected information can then be displayed on a CRT terminal.

Because IDENTIFIER recording and reporting is compatible with almost any interface, networking systems

can range from a simple Reader-Terminal hardwired connection to a multi-line mainframe system.

Personnel and Access Control Applications

Easily carried personnel tags enable the IDENTIFIER to be used in a variety of security and access control applications.



Advanced Information Systems:

The modern IDENTIFIER technology can function as the data input system for all the advanced information and control systems currently under consideration, making a practical contribution to concepts like radio-based signalling, automated car tracking systems, and nationwide ACI.

Combining Applications For Fast Payback And Maximum Return On Investment:

IDENTIFIER can save you money now, and in the future because the technology is so versatile and efficient that common equipment can be used for a variety of applications, offering the user the opportunity to add applications to a basic system, speeding payback, and increasing return on investment.

Some examples:

Tags on locomotives and Readers at yard boundaries will provide a System for locomotive maintenance, tracking, and dispatch. Then, by simply adding Readers at key OS points, the System will also provide OS reporting, train tracking, and dark territory cTc.

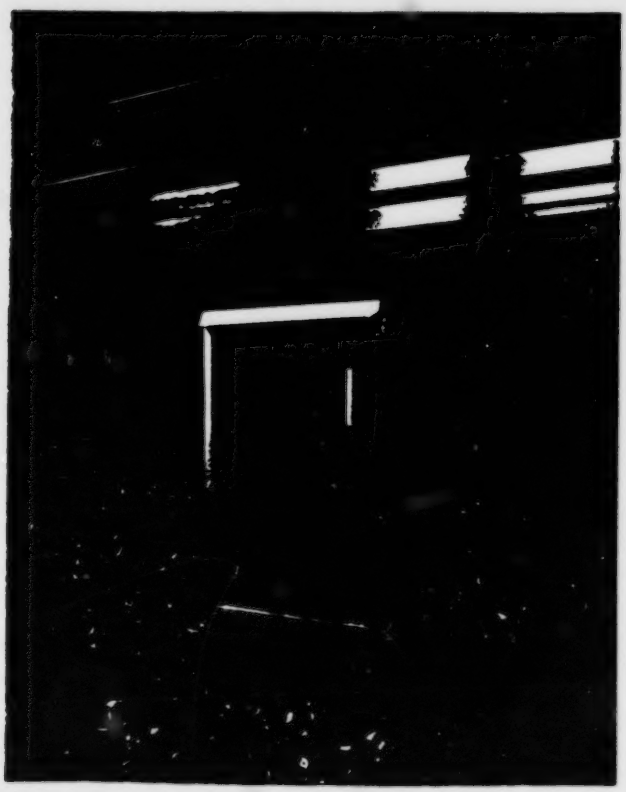
Tags used for automatic identification of hopper cars at weigh scales can also supply car identification at hot journal and flat wheel detectors.

Trailer Tags that tie in with state operated highway scales can also be used to track trailers in and out of intermodal facilities.

Readers reporting locomotive movements in and out of intermodal yards can also read TOFC, COFC, critical car, and unit train consist movements in and out of the same yards.

Readers that supply locomotive or train passing information at OS points can also be used to report fuel levels, operating conditions, and other dynamic data.

Best of all, the IDENTIFIER technology is adaptable. It will integrate easily with any other information gathering and reporting technology, today or in the future.



IDENTIFIER ELEMENTS AND TECHNICAL SPECIFICATIONS:

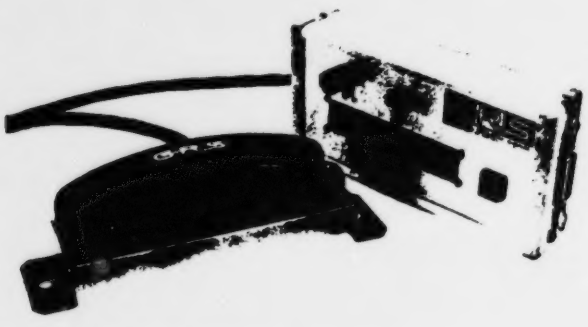
Identifier Tags:

The Fixed Coded Tags. These Tags are packaged in tough polycarbonate cases that offer high impact resistance, and are completely impervious to vibration, shock, dirt, dust, rain or snow, or climate extremes. A high temperature version is also available for prolonged temperature exposure up to 375°F.

They are completely passive, with no internal batteries or outside power sources required. And have a MTBF (Mean Time Between Failures) of 75 years. They mount quickly and easily almost anywhere.

These fixed coded tags are built around a sophisticated, proprietary LSI code chip that works reliably at extremely low power levels. The Tag is permanently coded (at the factory or in the field) to meet specific applications with up to 12 hexadecimal characters.

The Data (Variable Code) Tag. In this Tag, designed for dynamic data acquisition applications, the code chip is replaced by an electronic controller that multiplexes input data, and provides the modulation signal normally generated by the chip. This Tag has the same 12-digit code capability as the Fixed Code Tag, and the code information can be any combination of fixed or variable input. An attached code selector unit allows the Tag to be reprogrammed to meet changing conditions in the operating environment, or to accept input from analog or digital sensors supplying fuel level, temperature, pressure, or other critical operating parameters.



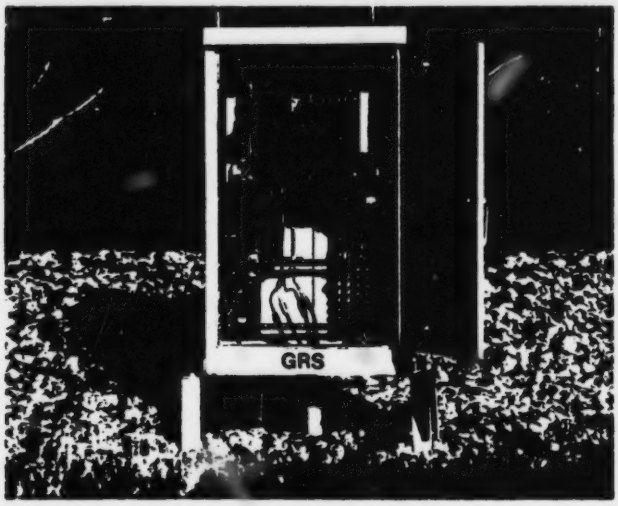
The Personnel Identification Tag. Fixed Code, Data, and Personnel Identification Tags can be read by the same IDENTIFIER Reader Station.

The IDENTIFIER Reader Station:

The IDENTIFIER Reader Station is a microprocessor-based unit that sends an RF signal to the Tag, via a transmitting antenna. The coded message returned by the Tag is decoded by the Reader and passed on to a Host/Recorder device. Information can be stored for later transmission, printed out directly, displayed on a CRT, or transmitted immediately.

The Reader can interface with a host computer, either directly or through a modem, with appropriate protocol conversion as required using a serial ASCII output signal; or, directly to a printer or other logging device. In either case, an IDENTIFIER Communications Module may be used to format and/or store the data for later retrieval.

The Reader Station is supplied with appropriate housing and power supply for wayside case, cabinet, or vehicle mounted applications. In addition to the continuous "sniff" mode, it can also be triggered by an external object detect switch.



The IDENTIFIER Antenna.

IDENTIFIER Antenna systems are housed in weather-protected enclosures that can be located up to 100 feet from the reader. Different antenna sizes and configurations are available to meet different applications. For instance, a low-profile, track-mounted antenna is available to read vehicle-mounted tags for applications such as automatic identification of vehicles and dynamic data acquisition. In an application where the reader is mounted on the vehicle to read tags along the wayside, a rugged

vehicle-mounted antenna is available. And for applications such as container identification, a long-range antenna is available for reading tags up to 25 feet away.

IDENTIFIER Vehicle Processor Module:

This optional module processes input from track-mounted wheel detectors, and furnishes car count, axle count, and direction information to the optional IDENTIFIER Communications Module.

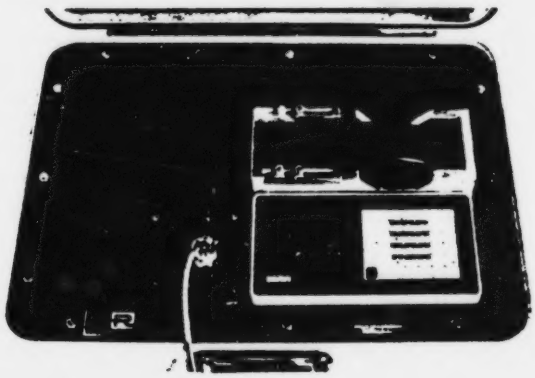
The IDENTIFIER Communications Module:

The optional IDENTIFIER Communications Module receives information from the Reader Station and the IDENTIFIER Vehicle Processor Module, then outputs a formatted message that includes: (1) location, date, time and direction of travel; (2) a listing of labels plus an indication of any unlabeled cars; and (3) a summary.

Each communications module can handle input from two Reader Stations and two Vehicle Processor Modules, and can accommodate up to 1000 identities. It will also handle input from other detectors or sensors (hot journal detectors, speed detectors, weight sensors, etc.).

IDENTIFIER Field Programming Unit:

The Field Programming Unit allows you to permanently code the Fixed Tag with the desired 12-character code, in a field location.



Optional Route Selection Module:

Provides Automatic Route Selection by controlling switch positions based on inputs received from Tags on approaching vehicles.

Optional Antenna Controller:

Adds to the versatility of the System by directing the Reader Station to identify and read through any of several different antenna systems.

MICRO TRAFFIC MASTER®

THE CONCEPT

GRS micro Traffic Master is a centralized traffic control system using GRS GENRALOGIC™ microprocessors to perform all office logic functions. You get a compact, efficient, all solid-state system that dispatchers (operators) can operate easily from a comfortable, human-engineered console.

The maintainer's work also is reduced by the simplicity of the system, its computer-generated documentation, and diagnostic test features. All these benefits are provided in the particular configuration you want because of GRS' long-standing ability to meet your individual needs. The modern, programmable micro Traffic Master makes it easier than ever to have the cTc features your operation requires.

ADVANTAGES

Management:

- Saves real estate, power, maintenance
- Reliable operation — totally solid-state
- Eliminates racks of nonvital relays and office code stepper units
- Can consolidate all types of cTc
- May be linked to other computers for automated dispatch or reporting systems
- Higher productivity
- Up-to-date design
- Fast, turnkey installation
- Field-proven

Operation:

- Human-engineered consoles
- Simplified keyboard entry
- Optional NX operation

Maintenance:

- Diagnostic indicators
- Standard pc boards — 4 to 6 types only
- No periodic maintenance
- Low spares requirements
- Bench test fixtures available for board repair
- Extensive documentation

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CONTROL CONSOLES

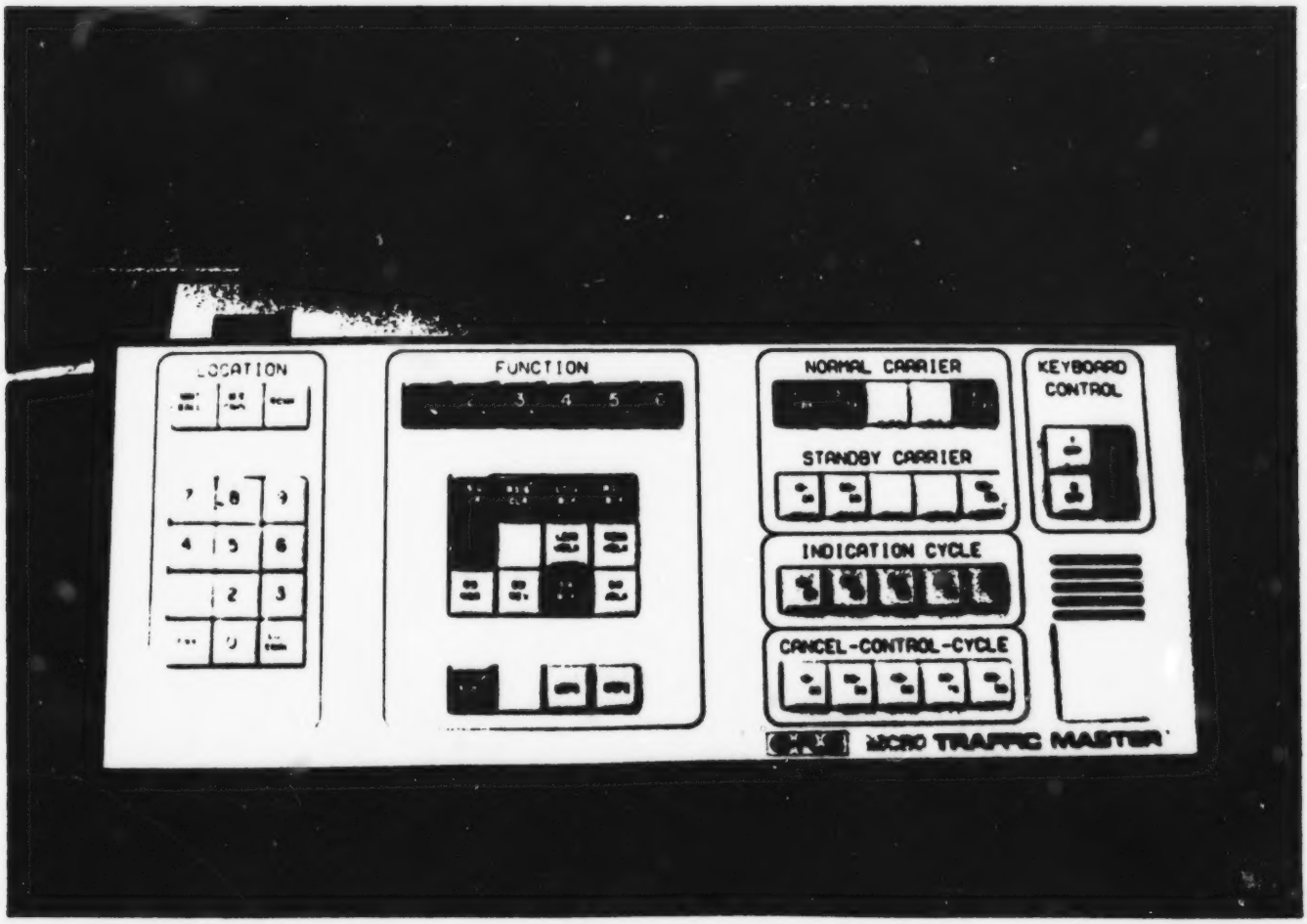
Modern GRS control consoles provide both operator comfort and increased productivity through extensive human-engineering. Operators use movable desktop keyboards for entering commands via function and number keys. The aluminum track display panels represent the controlled territory with all standard indications shown by long-life light-emitting diodes or color-filtered lamps. The track display panels are individually plug-coupled to permit easy replacement of only a small section if field changes are made. The scale of the diagram depends on the console size.

For applications where a single operator controls a territory, a miniature light console is available having an integral track diagram. For larger territories requiring more than one operator, a larger scale track diagram, visible from 25 feet, is mounted on a wall or rack pedestal for easy viewing. GRS modular design concepts permit many variations to meet your needs. All console equipment is manufactured to high GRS standards in our own facilities.

KEYBOARD

The micro Traffic Master keyboard simplifies operator inputs, namely, selection of a location and the functions desired. A minimum number of keystrokes performs signaling, blocking, and code system control. No more stretching for control levers that are beyond reach — everything is in one place. A clock and audible alarms may even be integrated into the keyboard.

In NX interlocking control, the traditional panel-mounted NX buttons can be provided to supplement the keyboard NX entry.



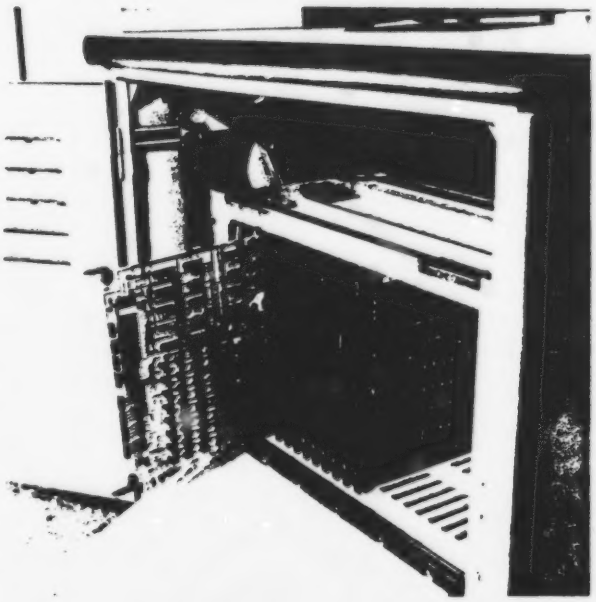
GENRALOGIC I THE KEY TO SIMPLICITY

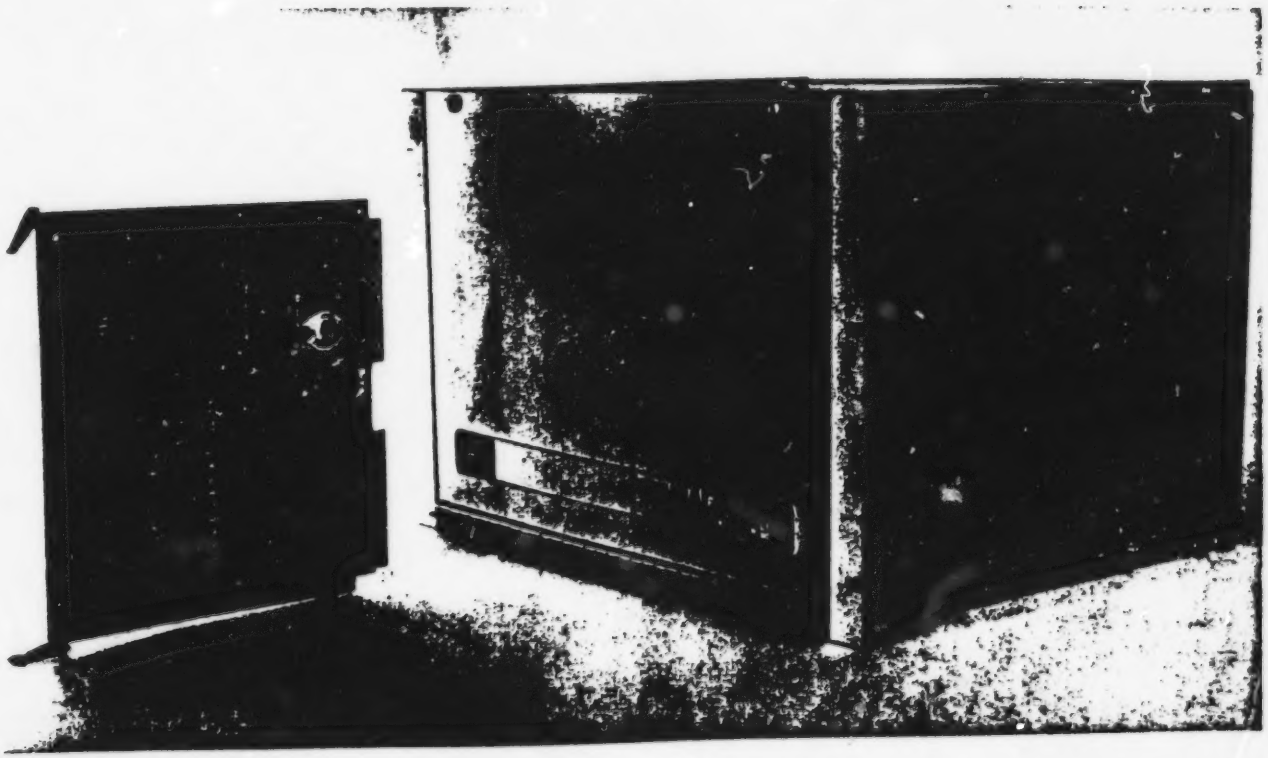
Traditional relay logic is straightforward, trouble-free, and long-lived. So is GRS GENRALOGIC I — but this solid-state controller is also compact, energy-efficient, and easily maintained, and can be updated by changes in the program — not by major circuit rewiring. In addition, GENRALOGIC I is a self-contained module, requiring no computer-style terminals, discs or special treatment. In fact, the GRS module meets all AAR environmental requirements for logic equipment.

In micro Traffic Master, GENRALOGIC I provides all the traditional functions of the nonvital relay application circuits, and those of any relay coding systems that might be used. In consolidations, no field changes are required, yet the office stepper units can be retired.

In large cTc or NX systems, the logic is distributed among several GENRALOGIC modules that are linked by a single cable. In the event of a problem in one module, only a fraction of the system operation is affected. And with only 4 or 5 types of circuit boards, quick return to service is assured.

FOR MORE DETAILS ABOUT MICRO TRAFFIC MASTER AND GENRALOGIC, CONTACT YOUR GRS SALES ENGINEER. OR WRITE FOR GRS PAMPHLET 1700, A COMPLETE TECHNICAL DESCRIPTION.





GRS AUTOMATIC TRAIN CONTROL

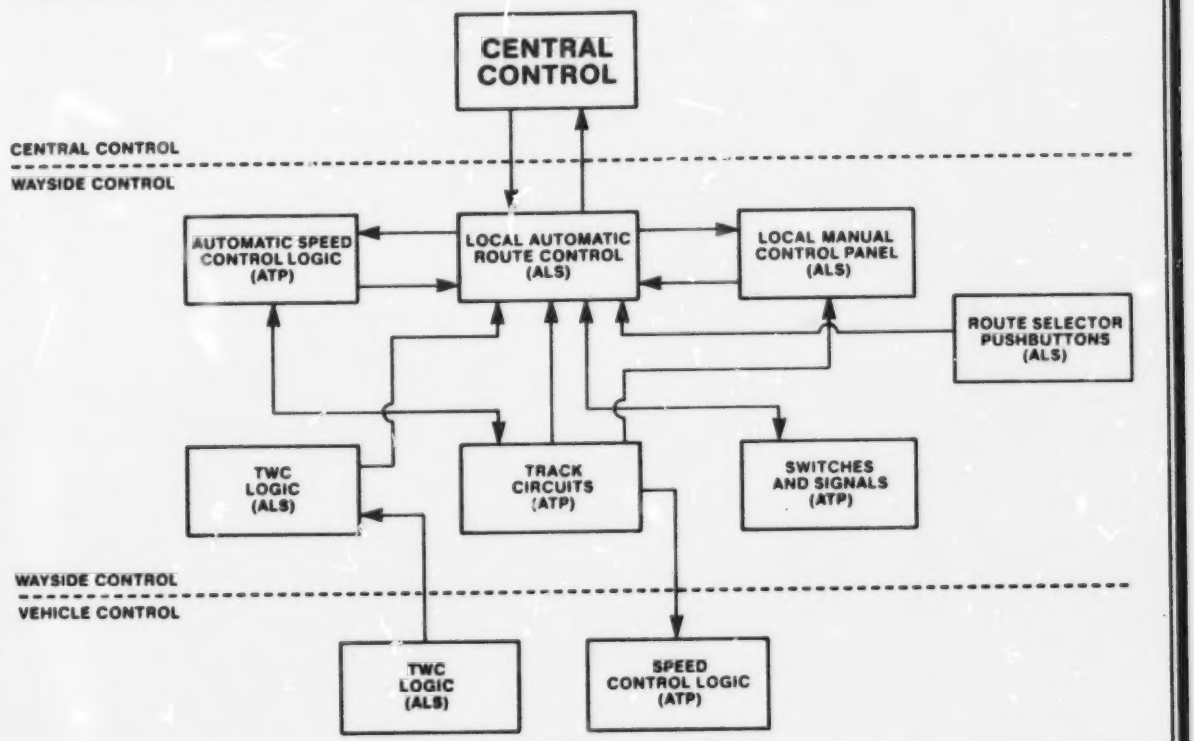


Figure 1. System block diagram.

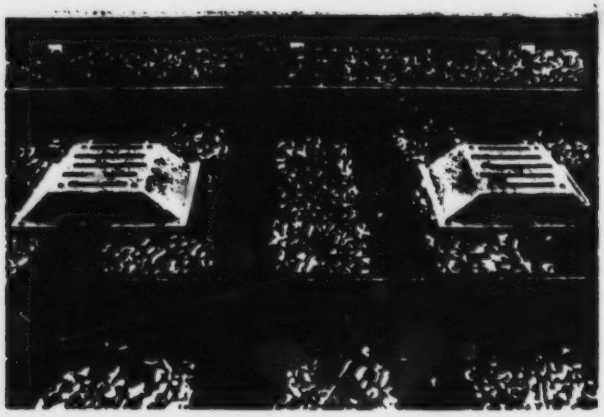
The train and traffic control system designed and installed by GRS consists of three major subsystems: automatic train operation (ATO), automatic train protection (ATP), and automatic line supervision (ALS). Each subsystem operates independently, with the entire operation coordinated and monitored by Central Control, a part of ALS. (Figure 1 is a top-level system block diagram.)

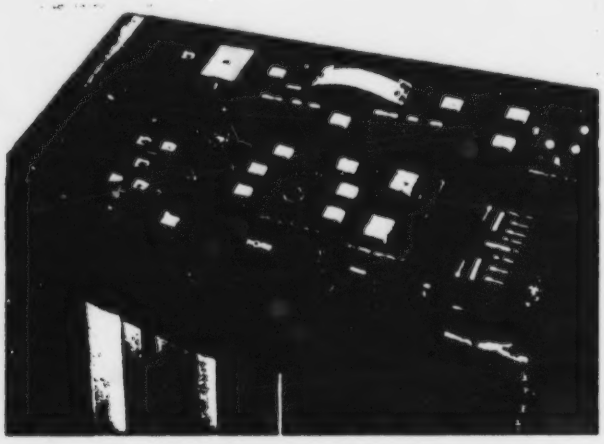
The ATO system regulates train speeds between stations and provides automatic station stopping, while the ATP subsystem ensures proper train separation and safe movement through interlockings. ALS initiates routes through switches automatically, dispatches trains automatically, and makes trains responsive to supervisor commands from Central Control. ALS communication between the train and wayside is via a GRS train-to-wayside communication (TWC) system.

The Central Control facility serves primarily to monitor the total transit system and to provide automatic dispatching. Corrective strategies are initiated manually.

The ATC system includes a data-transmission system (DTS) to transfer commands and indications between wayside facilities and Central Control.

AUTOMATIC TRAIN OPERATION





The MARTA ATO subsystem performs functions that are typically performed by a motorman. These functions include smooth acceleration of the train to running speed, regulation of that speed, and stopping the train smoothly at the proper position in the station.

The command velocity (reference velocity) for the train's speed control may come from one of two sources: the ATP speed command as modified by the ALS performance-level selection, or the ATO station-stop profile speed. The train responds to whichever of these two speed commands is the slower when in the station-stop mode, or to the ALS-modified ATP command when in the normal running mode.

In automatic stopping, the reference velocity of the train's speed regulator follows a decreasing velocity profile that terminates at zero speed at a predetermined target stopping point. Carborne ATC equipment generates the stopping profile. The target stopping point for the lead car is a variable depending on the length of the train. Distance markers (tuned coils) are located between the rails on the approach to the stop zone. The markers convey distance-to-go and stop alignment information to the train-carried equipment that makes any speed corrections necessary for an accurate stop. Each marker can be identified by the frequency at which it causes a carborne marker detector to oscillate.

The velocity profile always starts at a speed above the maximum running speed of the train. The value of the ATO speed command decreases along the profile until it becomes the same as the actual speed of the train. At the point where the ATO speed command becomes the lowest speed command, the train speed tracks the ATO station stopping profile.

DEPARTURE OF TRAINS

Routine train departure from a passenger station (other than a terminal or transfer point) is a local function which is monitored by Central Control. Dwell timers at all stations, in the absence of external intervention from Central Control, provide a train departure indication after a nominal time has elapsed after the train has arrived.

At certain terminal and transfer points, a dispatching function is employed that utilizes wayside signals for indicating scheduled departure time. The Central Control computer can initiate train departures based on a predetermined operating schedule. Dispatching is normally automatic and monitored by Central. In emergencies, a train can be dispatched by its operator, using trackside-mounted pushbuttons, and the train number stored in the train logic. The operator merely presses the local dispatch pushbutton to initiate departure.

AUTOMATIC TRAIN PROTECTION

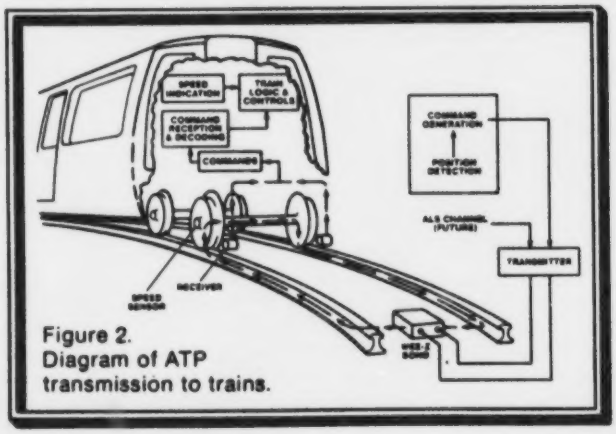
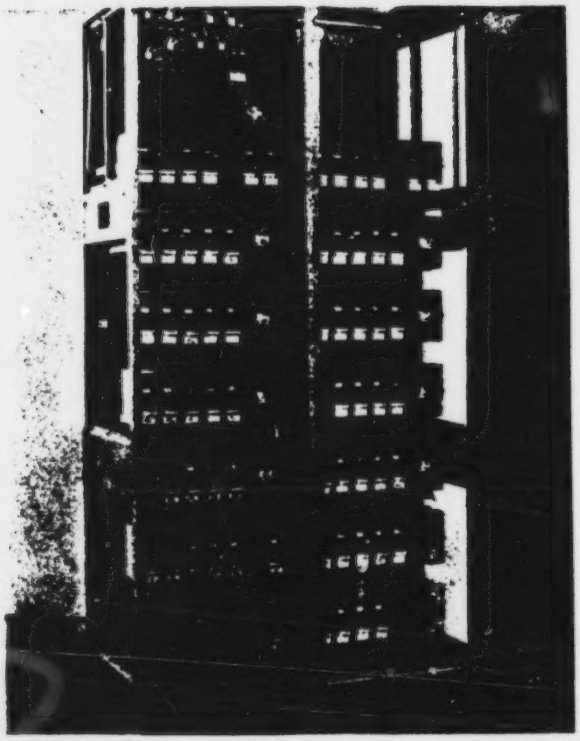


Figure 2.
Diagram of ATP transmission to trains.



The MARTA ATP subsystem enforces safe train operation. It imposes speed limits both to maintain safe train separation and to operate trains in accordance with civil speed restrictions. At interlockings, ATP ensures that train movement is permitted only when a route is available through the interlocking and the switches are safely locked in position.

TRAIN DETECTION

The MARTA track is divided into blocks that are checked for occupancy by means of audio-frequency track circuits. Except at interlockings, there are no insulated joints for block separation. Blocks are separated by tuned GRS WEE-Z* bonds, which also serve to inject into the track audio-frequency automatic speed commands picked up by the train.

GRS WEE-Z bonds are located at the ends of each track circuit. Generally, there is one track circuit per block, but for longer blocks there are two or more track circuits. In most cases, the WEE-Z bond is used as the transmitter coupling for one track circuit and the receiver coupling for the adjacent downstream track circuit.

An ATP command transmitter at the leaving end of the track circuit feeds audio-frequency energy to both rails of the track, using the WEE-Z bond as a coupling transformer. A WEE-Z bond at the entering end of the track circuit, acting as a receiver, energizes a track relay if the signal from the transmitter is not shunted by the axles of a train. The transmitter and receiver associated with one track circuit are tuned to the same frequency.

Adjoining track circuits use different frequencies to prevent unintended energization of a downstream track relay where the last car of a train has just passed over its bond. The assigned frequencies are not used again until they are far enough away so that the AF track signal is unable to energize a track relay in another track circuit. In addition, a different set of four frequencies is used on each track.

To protect against false generation of a "clear" indication by an oscillating track-circuit receiver, the track-circuit energy is modulated on and off several times a second. A steady receiver output is interpreted as a circuit failure and causes the signal system to assume the block is occupied by a train.

AUTOMATIC SPEED COMMANDS

The AF track circuits are used as the communication channels between wayside and train for the ATP speed-limit commands. In addition, the WEE-Z bonds and rails provide the transmission medium for the TWC system. The ATP speed command channel is assigned a frequency separate from the train-detection and TWC frequencies.

Receiver coils are mounted on the cab end of each car, ahead of the first axle. These coils are sensitive to the magnetic fields caused by the audio-frequency current flowing from the next downstream impedance bond to the head end of the train on one rail, through the first axle of the train, and back to the transmitting bond on the other rail.

Each WEE-Z bond is tuned to the frequencies of all the channels existing at its location. These frequencies include those for train detection in the two adjoining blocks, speed-limit commands to the train and TWC.

The ATP commands applied to the bonds for transmission to the train are determined by the state of the track relays corresponding to downstream track circuits, the state of downstream interlockings, and the maximum speed allowed for the next downstream segment of track. An example of the last factor is a speed limit for a curve.

All circuits that select the speed command to be transmitted to MARTA trains use vital relays which protect the safety of the controlled operation. Such relays are specially constructed, having, for example, gravity-drop armatures and nonfusing contacts.

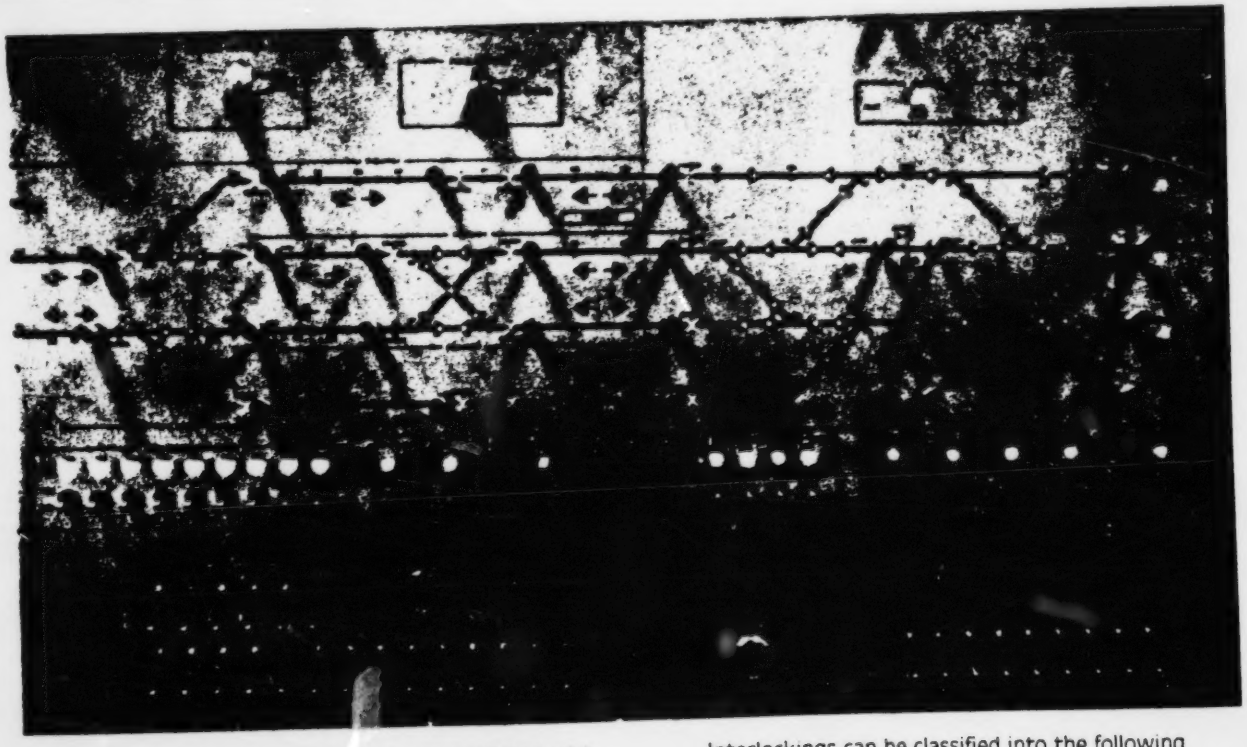
For each track circuit, a signal must always be transmitted for purposes of train detection. However, ATP speed commands are transmitted only when the block is occupied.

If there are no clear blocks ahead and the appropriate command is to stop the train, no speed signal is transmitted. This condition is interpreted on the train as a stop command.

MARTA carborne ATP equipment enforces the speed limit transmitted to the train by performing the following functions:

1. Receives and decodes the speed-limit commands.
2. Measures train speed and compares it to the speed limit.
3. Permits application of tractive effort.
4. Initiates safety braking in the absence of a speed command, the presence of an overspeed condition, or a system failure that affects safety.

INTERLOCKINGS



Route selection at each interlocking is accomplished with GRS NX (eNtrance-eXit) interlocking principles.

NX is a proprietary interlocking control process of GRS. With NX, an operator does not control individual signals and switches but only inputs the entrance and exit points of a route through an interlocking. The NX control logic selects the best available route and locks out the possibility of selecting conflicting routes.

The MARTA system has three ways to provide routing information:

1. Local automatic control by the TWC system. Also, some terminal interlockings are controlled automatically by a train approaching the terminal (track circuits). In some cases a combination of the above is used.
2. Remotely, by Central Control.
3. Locally, by the local manual NX control panel.

Interlockings can be classified into the following general categories, with some locations combining features of two or more:

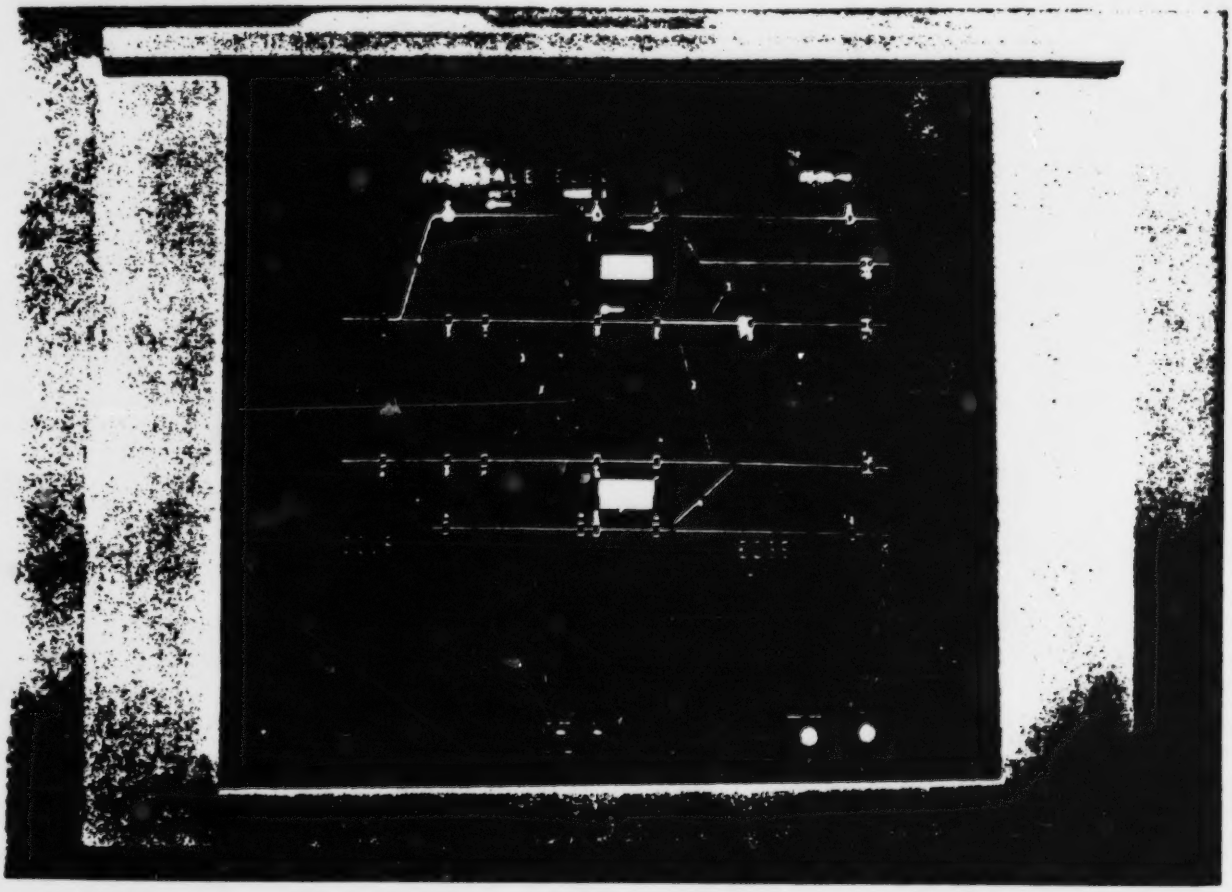
1. Intermediate double crossovers.
2. Divergent route interlockings.
3. Terminal interlockings.

At intermediate crossovers, the straight-through route is normally aligned automatically by local line supervision, either by train destination or approach of a train. Central Control or control from a local panel can override the route to select crossover routes if a mainline route is blocked.

At divergent route interlockings, the points where branch lines join the main transit route, all three methods of setting up routes are available, but automatic wayside is the normal method of control. Routes are requested by the destination data transmitted from the train.

Interlockings for terminal passenger stations are controlled automatically by track circuits and dispatching as discussed above.

AUTOMATIC LINE SUPERVISION

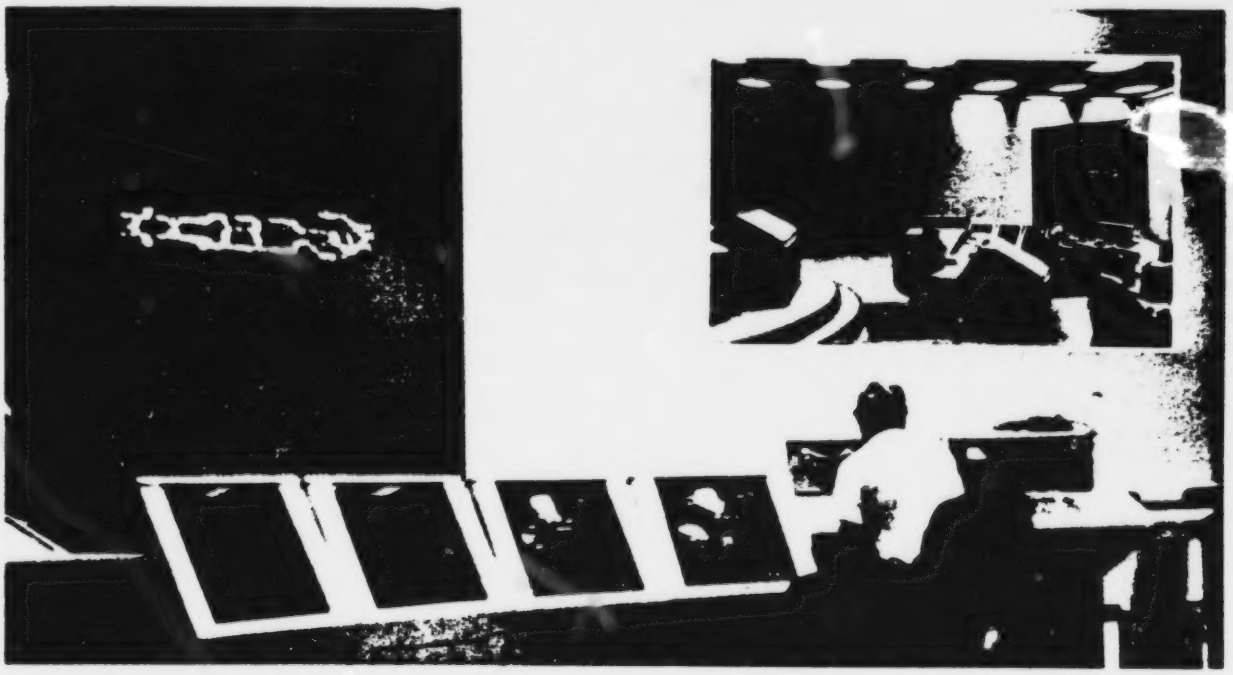


MARTA's ALS subsystem provides a train-ready signal, a train identity, and a dispatch command that is similar to a route request. The subsystem also provides the medium for transmitting this information to Central Control, where the data are used to automatically update displays. ALS also supplies similar data to other computer programs that compile operating statistics.

Train number and destination data are transmitted to the Central Control computer each time the train enters a passenger station. Central tracks the train's progress by block-occupancy data. (The state of the ATP-system track relays is also reported to Central.) When the train reports its number at a station, Central correlates the train number with block occupancy and thus can locate each train by number, at stations and between stations. When the train reports that it has stopped at a passenger station by transmitting its train message and a train-stopped signal, Central checks arrival time against a schedule and, if the train exceeds schedule tolerances, an alarm sounds. Corrective strategies by Central Control are manually initiated.

The destination data in train memory are transmitted to the wayside via the TWC system, to automatically initiate routes through certain interlockings. Train number, train length, and destination data can be loaded into the train's memory by thumbwheel switches in the cab of the leading car. System hardware is designed to permit the expansion of TWC to automatically load train identification selected from Central Control. The initial installation for MARTA provides one-way communication from the train to the wayside.

CENTRAL CONTROL



Central Control and the data-transmission system that links it to the wayside equipment complete the ATC system. The primary functions of the Central Control facility and data-transmission system are to monitor the status of the total transit system and display appropriate status information for Central Control personnel.

The Central Control facility is divided into four functional areas:

1. Central data-transmission subsystem (CDTS).
2. Console control and console equipment.
3. Display board control and interface.
4. Dispatch control and data compiler (DCDC) and its peripheral devices.

System status received via CDTS updates the display panel and the console control. Console control provides current displays on color and black-and-white video display units for Central Control operating and supervisory personnel. Console control also performs the functions of data logging and alarm generation. Manual inputs from Central Control personnel are processed by console control and transmitted to the DTS when they necessitate commands to the field.

The dispatch control and data compiler serve both on-line and off-line functions. In the initial stage of manually generated corrective strategies, the DCDC is responsible for automated dispatching and for providing operating personnel with performance analyses (on-line and off-line) to aid in manual system optimization.

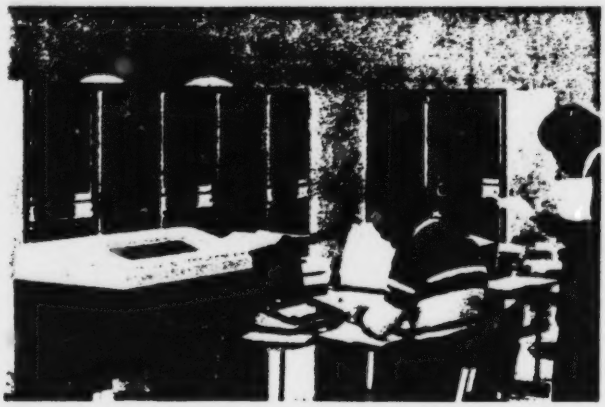
DATA-TRANSMISSION SYSTEM

MARTA data-transmission system (DTS) provides the data links from Central Control to the local line supervision equipment. The DTS consists of remote units located in the train-control equipment rooms and the central data-transmission system in the central facility. This system, which utilizes voiceband channels of a carrier transmission system, collects the data concerning train operation and system status for use by Central Control and transmits commands from Central to the field locations.

The local data-transmission subsystems (LDTS) serve as focal points for collecting and relaying data to Central. They also receive commands from Central Control for transfer to the local equipment.

The CDTS–LDTS combination provides transmission error detection for both directions of transmission. If an error is detected in a received message, the message is ignored and retransmission is initiated. A second consecutive failure results in an alarm.

PAST IS PROLOGUE



The technology employed on the MARTA system is the culmination of experience GRS has gained in rapid transit since 1904. It's estimated that GRS has supplied more miles of rapid transit signaling and control systems than any other supplier in the world.

All three of MARTA's control systems—ATO, ALS, and ATP—are operating on Washington Metro, while ATP serves Cleveland and Chicago, and ATO is operating in Boston. Equipment for full ATO and ATP also has been provided to New York City.

MARTA's ALS subsystem, when integrated by central computer with the ATO and ATP subsystems, provides the latest dimension in transit-control technology. The combination gives Atlanta one of the most sophisticated and advanced control systems in the world.

MARTA continues the GRS position of technological leadership in rail transportation, held since the turn of the century. The position, strengthened by the design and installation of controls for Washington Metro, receives confirmation with Atlanta.

For more information about GRS capabilities in rail rapid transit, call your General Railway Signal sales engineer. Or contact GRS and ask for Bulletin 200.

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230 Park Avenue, New York, NY 10017.
Phone: 212-697 3681

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St. Louis Office
Laclede Gas Building, 720 Olive Street,
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Northwestern National Bank Building, Suite 1380,
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Washington Office
Montgomery Center, Suite 613, 8630 Fenton Street,
Silver Spring, MD 20910. Phone: 301-587-4770

THE CABMATIC FAMILY OF TRAIN CONTROL EQUIPMENT

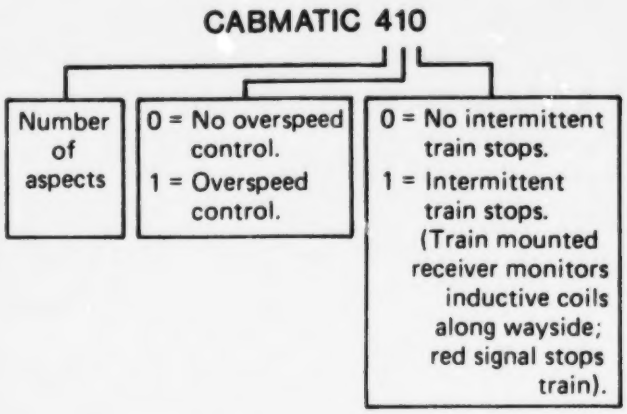
The GRS Cabmatic family is a group of compact cab signal and speed control systems, designed for use on locomotives, cab cars, and rail transit vehicles.

Cabmatic System Designations. The Cabmatic family of systems is designed to meet your specific applications. For convenience, these systems are given a three-digit numerical designation which describes the system characteristics.

These three-digit numerical designations indicate: number of aspects (1st digit); presence or absence of overspeed control (2nd digit); and presence or absence of intermittent train stops (3rd digit).

This example describes the Cabmatic 410 as a four-aspect system, with overspeed control and no intermittent train stop.

Example:


CABMATIC 410
Number of aspects
0 = No overspeed control.
1 = Overspeed control.
0 = No intermittent train stops.
1 = Intermittent train stops. (Train mounted receiver monitors inductive coils along wayside; red signal stops train).

GRS CABMATIC TRAIN CONTROL INSTALLATIONS

Property	Cabmatic Type Number*	Rolling Stock	Number of Sets	Cab Signals	ATP-Cab Signals With Overspeed Control	ATO-Speed Regulation & Station Stops	ATS - Train-Wayside & Wayside-Train Communications	Brake Assurance	Number of Indications or Speeds	Frequency in Hertz
Amtrak	411	L	100	X	X				4	60/100
Brazil Nat. Railway	400	L	9	X					4	100
Budd SPV 2000	410	C	1	X	X				4	60/100
Conn. DOT	410	L	4	X	X				4	100
C&NW	211	L/C	340	X	X				2	100
CTA	H510	C	1132	X	X				4-5	4550
GCRTA/Cleveland	H410	C	143	X	X				4	4550
Disneyland	---	L	3						4	Ck.In/Out
Illinois Central	200	L	2	X					2	100
Iron Ore Company	H1110***	L	10	X	X	X			11	4550
MARTA Atlanta	H610	C	140	X	X	X	X	Note 2	6	2340
MBTA Boston	H810	C	367	X	X	Note 1		Note 3	8	4550 5525 990
MTA/N.Y.	410	L/C	28	X	X				4	100
Netherlands NS	---	L/C	770	X	X				5	75
N.J. DOT (EL)	400	C	130	X					4	100

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Cabmatic System Description. Two types of Cabmatic systems are available: those using high-frequency track circuits and those using power-frequency track circuits. For a detailed description of CABMATIC high-frequency systems, see Folder 293; for CABMATIC systems using power-frequency track circuits, see Folder 271.

GRS CABMATIC TRAIN CONTROL INSTALLATIONS (cont'd)

Property	Cabmatic Type Number*	Rolling Stock	Number of Sets	Cab Signals	ATP-Cab Signals With Overspeed Control	ATO-Speed Regulation & Station Stops	ATS - Train-Wayside & Wayside-Train Communications	Brake Assurance	Number of Indications or Speeds	Frequency in Hertz
NYCTA (R44)	H610	C	184	X	X	X			6	990
NFTA/Buffalo	510	C	26	X	X		X	X	5	100
Penn Cnt. New Haven	410	L/C	155	X	X				4	100
Penn Cent. SEPTA	400	C	138	X					4	100
Penn Cent. Springfield	210	L	90	X	X				2	140
Penn Cent. Turbos	400	L	2	X					4	60/100
Reserve Mining	400	L	3	X					4	60
RTA/Chicago	411	L/C	105	X	X				4	60/100
SF Bay Bridge Ry.	410	C	88	X	X				4	100
Seattle Monorail	410	L	2	X	X				4	120
Union Pacific	310	L	28	X	X				3	60
WMATA Washington	H1000**	C	150	X	X	X	X		10	4550 5525
U.S./Dot Act I	H610	C	2	X	X				6	4550 5525
U.S. Steel	100	L	5		X				1	100

Legend
C – car
L – locomotive

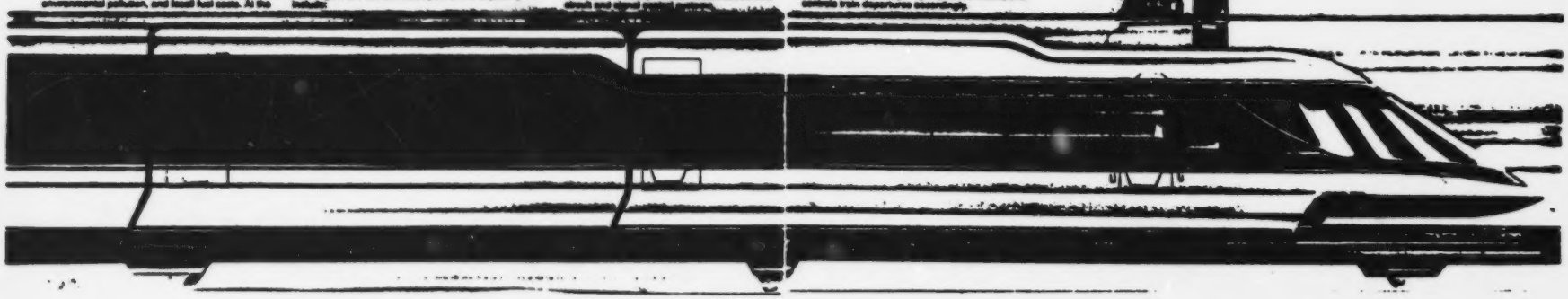
NOTE 1: Speed regulation only
NOTE 2: 65 sets
NOTE 3: 263 sets

*Numbers with H preceding them indicate installations using high-frequency track circuits (audio range). All other installations use power-frequency track circuits.

** Indicates a 10 aspect system *** Indicates an 11 aspect system

GRS CONTROL AND INFORMATION CAPABILITIES FOR HIGH SPEED RAIL.

GRS



SPACERAIL™

Vital Radio-Based Signal and Control

- Economical signaling for territories you could never justify signaling before.
- A system that builds on your existing equipment and technology.

SPACERAIL is a vital location, communication and control system that:

- Locates trains using proven GRS IDENTIFIER® technology.
- Provides vital communications links between control office, trains, and field equipment using proven, vital microprocessor technology.
- Increases the dispatcher's span of control from the central office.
- Displays signals in the cab.

SPACERAIL uses proven, "off the shelf" equipment and proven vital microprocessor application techniques. Under test in some of the most rugged terrain and environment in North America, SPACERAIL is being developed for use in a variety of railroad traffic control applications.

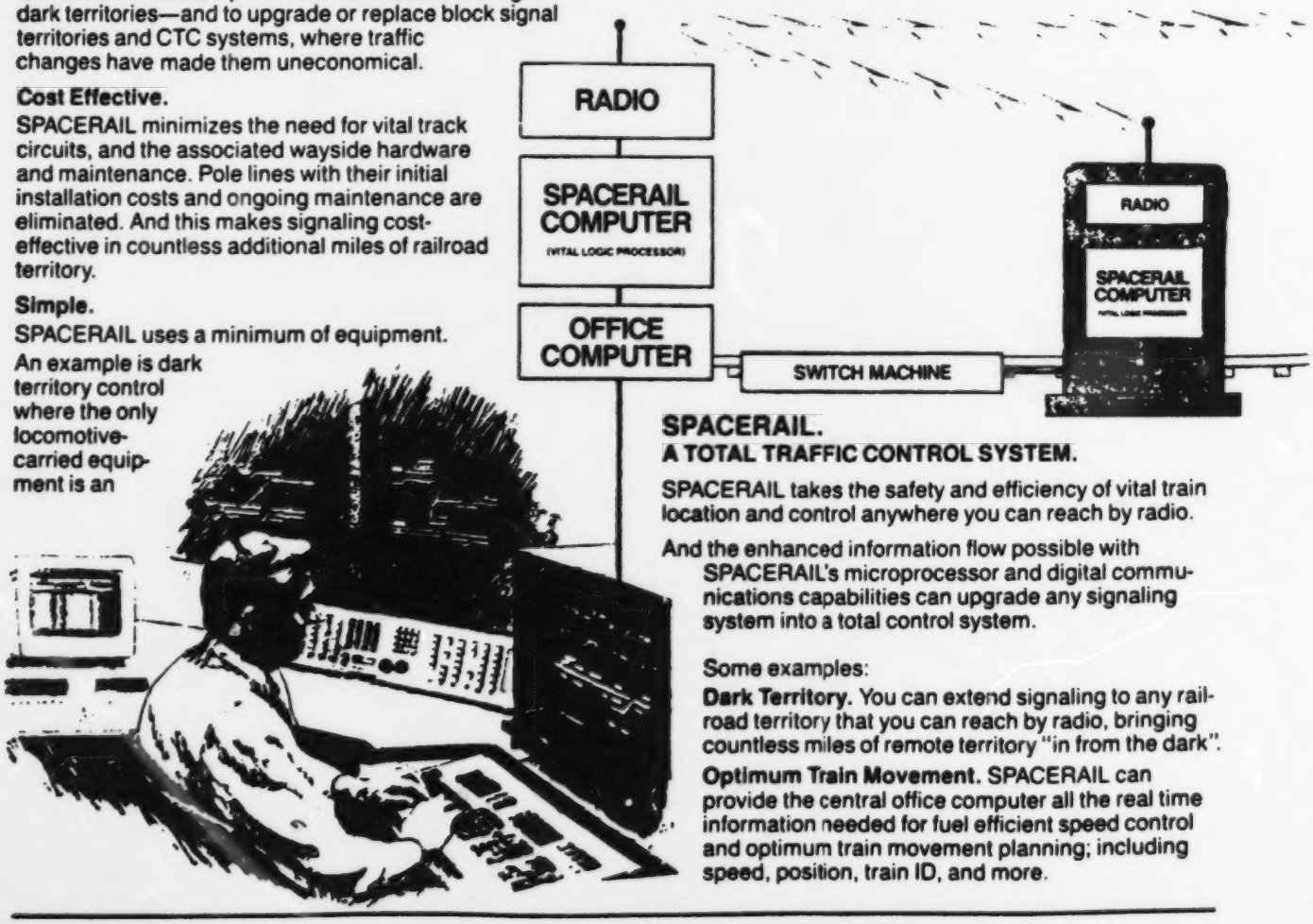
SPACERAIL makes it practical and affordable to signal dark territories—and to upgrade or replace block signal territories and CTC systems, where traffic changes have made them uneconomical.

Cost Effective.
SPACERAIL minimizes the need for vital track circuits, and the associated wayside hardware and maintenance. Pole lines with their initial installation costs and ongoing maintenance are eliminated. And this makes signaling cost-effective in countless additional miles of railroad territory.

Simple.
SPACERAIL uses a minimum of equipment. An example is dark territory control where the only locomotive-carried equipment is an IDENTIFIER Reader and a SPACERAIL Vital Communication Processor. The existing train radio may be used as a vital communication medium, providing additional economy.

Control of vital and non-vital wayside equipment requires only a radio, the SPACERAIL Vital Processor, and your existing relay-based vital logic circuits. You can even eliminate the need for vital logic relays by using SPACERAIL Vital Interlocking Logic.

Reliable.
SPACERAIL is primarily a vital communications system. Control processing is done in the central office, not on-board the locomotive, minimizing on-board hardware and increasing reliability and flexibility.



SPACERAIL.
A TOTAL TRAFFIC CONTROL SYSTEM.

SPACERAIL takes the safety and efficiency of vital train location and control anywhere you can reach by radio.

And the enhanced information flow possible with SPACERAIL's microprocessor and digital communications capabilities can upgrade any signaling system into a total control system.

Some examples:

Dark Territory. You can extend signaling to any railroad territory that you can reach by radio, bringing countless miles of remote territory "in from the dark".

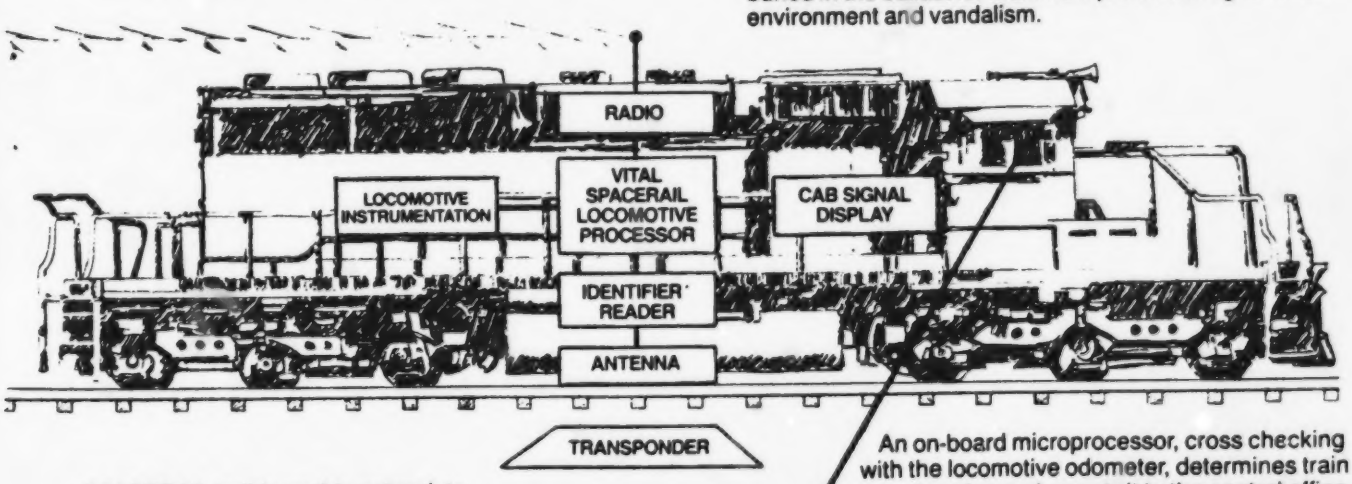
Optimum Train Movement. SPACERAIL can provide the central office computer all the real time information needed for fuel efficient speed control and optimum train movement planning; including speed, position, train ID, and more.

Locomotive Monitoring. Using train-mounted sensors, SPACERAIL can monitor locomotive performance (oil pressure, temperature, fuel level, compressor performance, etc.) for maintenance planning and ongoing analysis.

Advanced Traffic Control. SPACERAIL can accommodate train control functions like speed control, interlocking control, and more.

SPACERAIL.
BUILDING BLOCKS FOR TOMORROW.

With SPACERAIL, you use what you already have today to build for tomorrow, because the cornerstone of the SPACERAIL system is already installed and working on your railroad: a reliable radio communications network that links your dispatchers and the trains they control.



SPACERAIL builds on this network to extend the safety and efficiency of signaling traffic control anywhere you can reach with radio.

And the more complete your radio coverage, the more effective use you can make of SPACERAIL.

Control Where It Belongs. In The Office.

With SPACERAIL, control decisions are made where they should be made—in the central office; not by putting expensive advanced control processor power on each locomotive in the field.

And SPACERAIL's "building block" concept lets YOU decide what level of control is right for each part of your railroad, integrating easily into any modern CTC office, and with any current or future display technology.

Typical SPACERAIL Building Blocks include:

- Vital automatic train location and identification.
- Vital switch and wayside equipment control.
- Vital cab signals.
- Train health monitoring.
- Non-vital wayside equipment control.

SPACERAIL AT WORK.

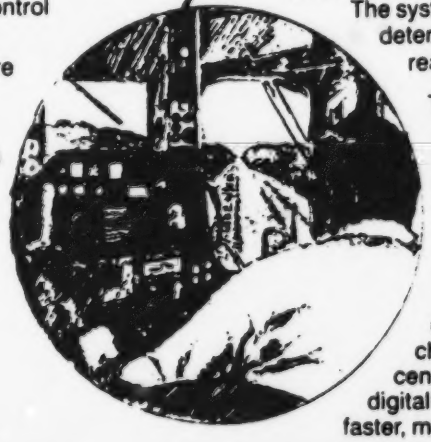
Train Location

Trains are located and identified using proven GRS IDENTIFIER technology.

The rail network is divided into zones, identified by passive wayside transponders. Train location is determined by a locomotive-carried GRS IDENTIFIER Interrogator reading a wayside-mounted GRS IDENTIFIER transponder (tag).

These passive tags are wayside-mounted at strategic locations to provide location identification, and can be buried in the ballast for maximum protection against the environment and vandalism.

An on-board microprocessor, cross checking with the locomotive odometer, determines train location and reports it to the central office. The system includes provision for determining the location of the rear of the train.



The central office computer processes the information received from the train and maintains a current status and location update.

Communications Capability

The SPACERAIL System uses a duplex radio channel between cab and central office; and modern digital communications for faster, more efficient operations.

Rockwell ARES: Advanced Railroad Electronics System

Rockwell International's ARES, the Advanced Railroad Electronics System, is now being implemented in the railroad industry with production hardware. Now railroad companies have the capability for real-time communications and accurate command and control of railroad units.

Rockwell ARES offers benefits of cost, capability, safety, and efficiency not found in any other electronics system available to the railroad industry:

Advanced digital communications:
- On-board receipt, acknowledgement, and display of train orders, warrants, wayside alerts, and other information;
- Automated crew time and payroll-related reporting;
- More efficient utilization of assigned radio channels.

Precise electronic control:
- Accurate, continuous, real-time knowledge of position and operating situation of trains, hy-rail vehicles, and track maintenance equipment;
- Computer-enhanced monitoring of compliance with automatic alerts and warnings;
- Advanced traffic planning with automated updates based on actual performance-to-plan.

Expanded command capabilities:
- Direct dispatcher intervention in hazardous traffic situations (remote intervention);
- Electronic enforcement of operating instructions and schedules.
- Improved dispatching system flexibility and productivity.

Improved asset utilization:
- Increased traffic capacity on all classes of track without traditional expensive wayside installations;
- Reduced fuel consumption through more efficient operation of trains and more effective scheduling;
- Reduced locomotive maintenance expense;
- Improved throughput for locomotives and cars;
- Increased productivity of maintenance-of-way forces.

Seven basic subsystems. ARES consists of the following integrated subsystems:

Data Management System
Rail Operations Control System
Locomotive Analysis and Reporting System
On-Board Display System
Train Location System
Energy Management System
Wayside Interface System

Data Management System

At the heart of Rockwell ARES is the Data Management System. The main element is an on-board data management unit that provides for: 1) integration and automation of information exchange among the on-train systems, and; 2) interface to the ground-based ARES system. By utilizing digital-data communications, the data management system:

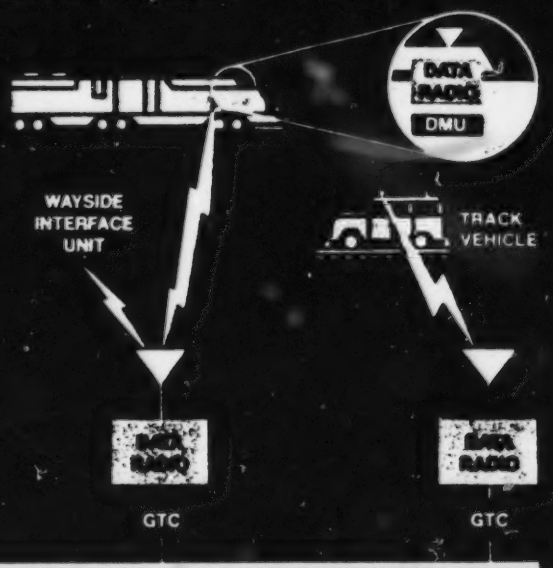
- Reduces radio congestion by replacing many voice conversations with automatic data transmission.
- Establishes a computer-controlled data path that includes unique addresses for each control element, automatic message checking and, if required, retransmission.
- Provides message display and/or hard copy printouts.

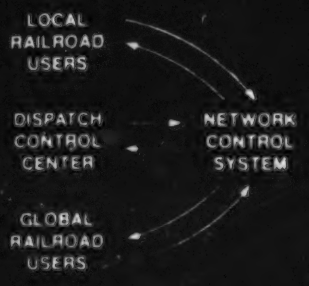
The data management unit also provides for:

- Orders, restrictions, clearances, and control commands.
- Authority and speed limit adherence.
- Wayside device control and status.
- Intra-train information.
- Setout and pickup instructions.
- Crew identification and time reporting for payroll and other uses.
- Remote intervention.

Data management system hardware comprises the data management unit outlined above as well as: 1) the *network controller*, which manages ARES communications through a wayside distribution network, 2) *ground terminal controllers*, co-located with existing radio sites, that complete the ground-to-mobile vehicle communications network, and 3) *wayside interface units* that monitor manual switches, interface to power switches, or provide a digital communications link to existing wayside logic devices.

In conjunction with other ARES subsystems, such as the Locomotive Analysis and Reporting System, the Data Management System is the central information transfer point among the locomotive sensors, LARS computer, train engineer, control/dispatcher center, and maintenance facilities.





DMU – DATA MANAGEMENT UNIT
GTC – GROUND TERMINAL CONTROLLER
TRANSCEIVER

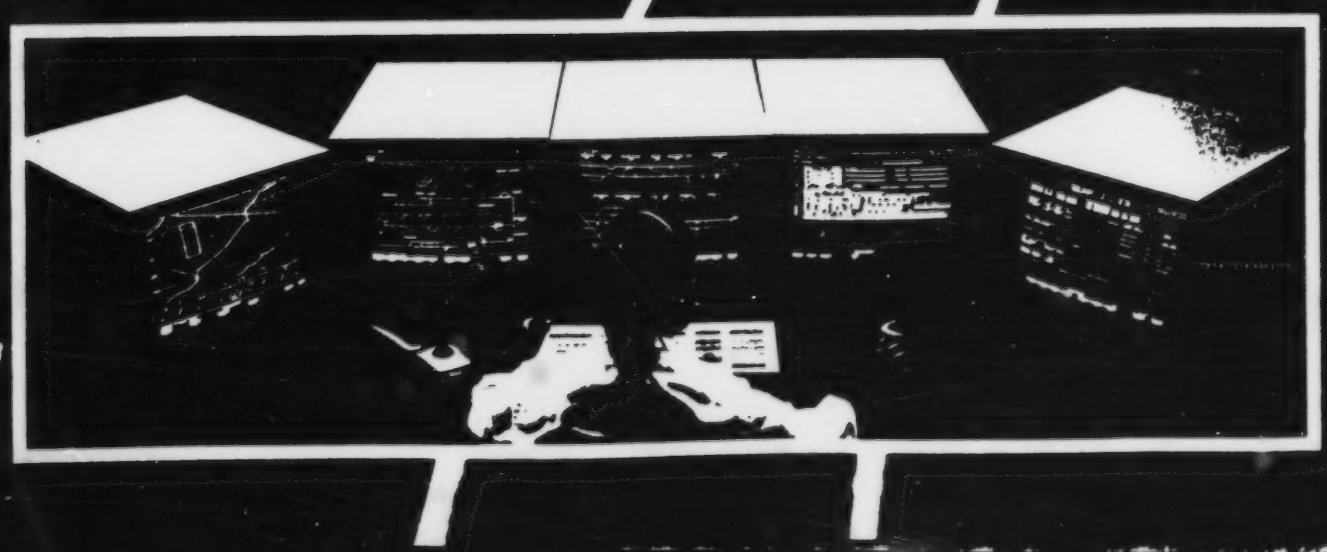
Rail Operations Control System

The Rail Operations Control System (ROCS), a Rockwell ARES subsystem, is an advanced control and dispatching system that generates orders, monitors safety, determines compliance, optimizes traffic flow, and assists the dispatcher in making control decisions.

From an advanced work station with multiple color CRT displays, the dispatcher calls up color-coded displays on track configuration and status, which show position of each train operating within the dispatcher's territory, along with its identity, speed and current clearance authority limit.

The dispatcher is able to call up any information at any time that he deems necessary. Warnings and violations of authority limits or speed limits are displayed automatically. And, from the ROCS center, the dispatcher has the ability to remotely intervene by stopping the train.

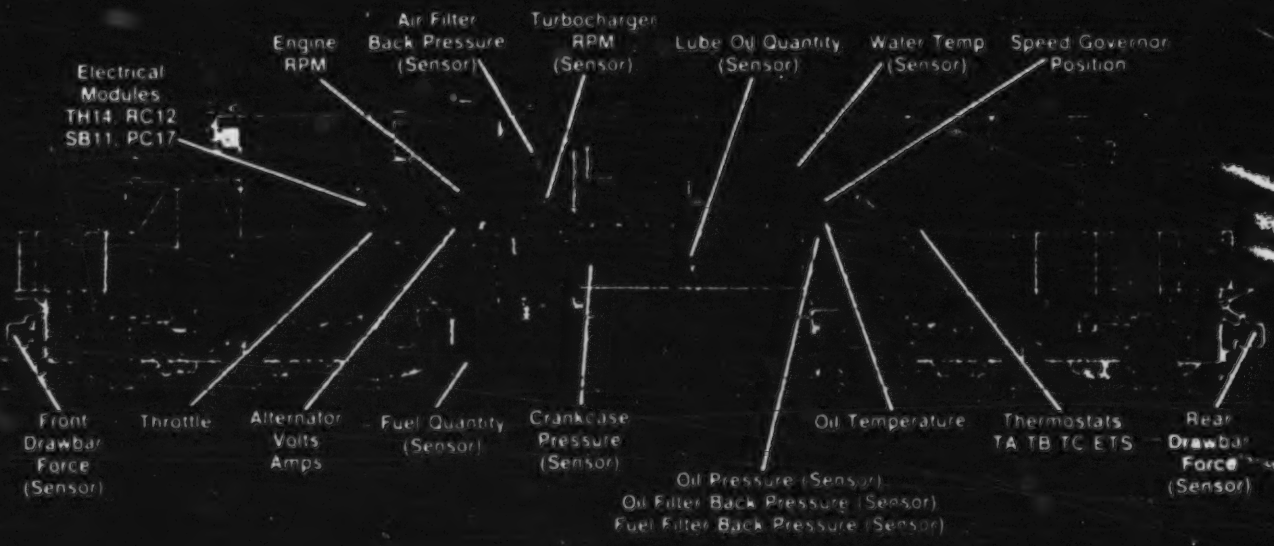
The Rail Operations Control Center is ergonomically engineered to accommodate both voice communications and train control in one work station, thereby reducing dispatcher workload and enhancing safety.



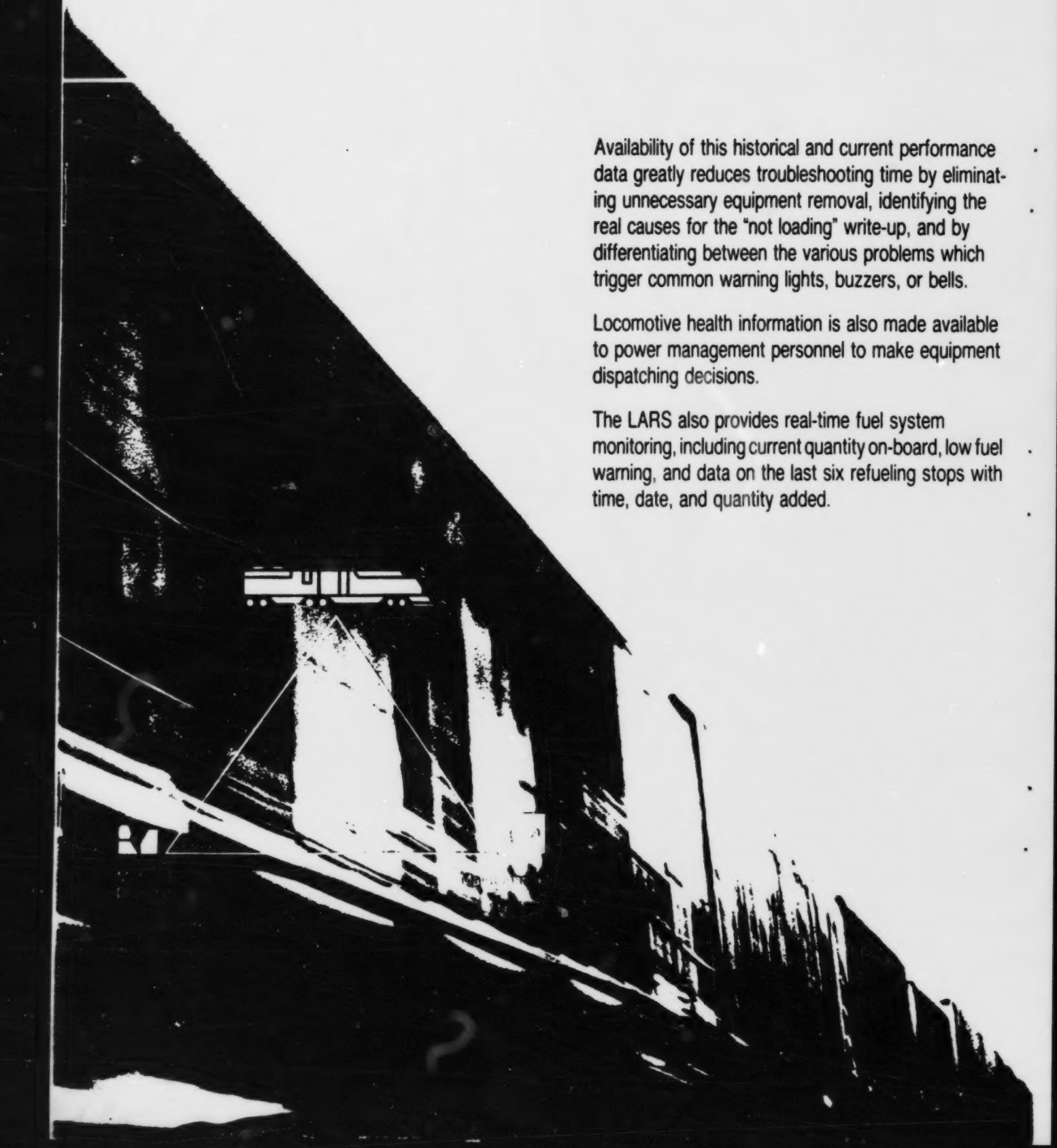
Locomotive Analysis and Reporting System

The Locomotive Analysis and Reporting System (LARS) monitors health and efficiency of the locomotive by utilizing a number of unique sensors and typical locomotive discrete signals. Consequently LARS also warns of impending failures in locomotive systems.

The LARS computer makes performance data available to the train engineer through the ARES locomotive display. Exceedances and diagnostic data are transmitted via the ARES Data Management System directly to the mechanical maintenance facility. For retrieval at a later time, LARS stores the history of incidents in which locomotive system values have exceeded the normal range.



ARES LARS M[illegible] Locations



Availability of this historical and current performance data greatly reduces troubleshooting time by eliminating unnecessary equipment removal, identifying the real causes for the "not loading" write-up, and by differentiating between the various problems which trigger common warning lights, buzzers, or bells.

Locomotive health information is also made available to power management personnel to make equipment dispatching decisions.

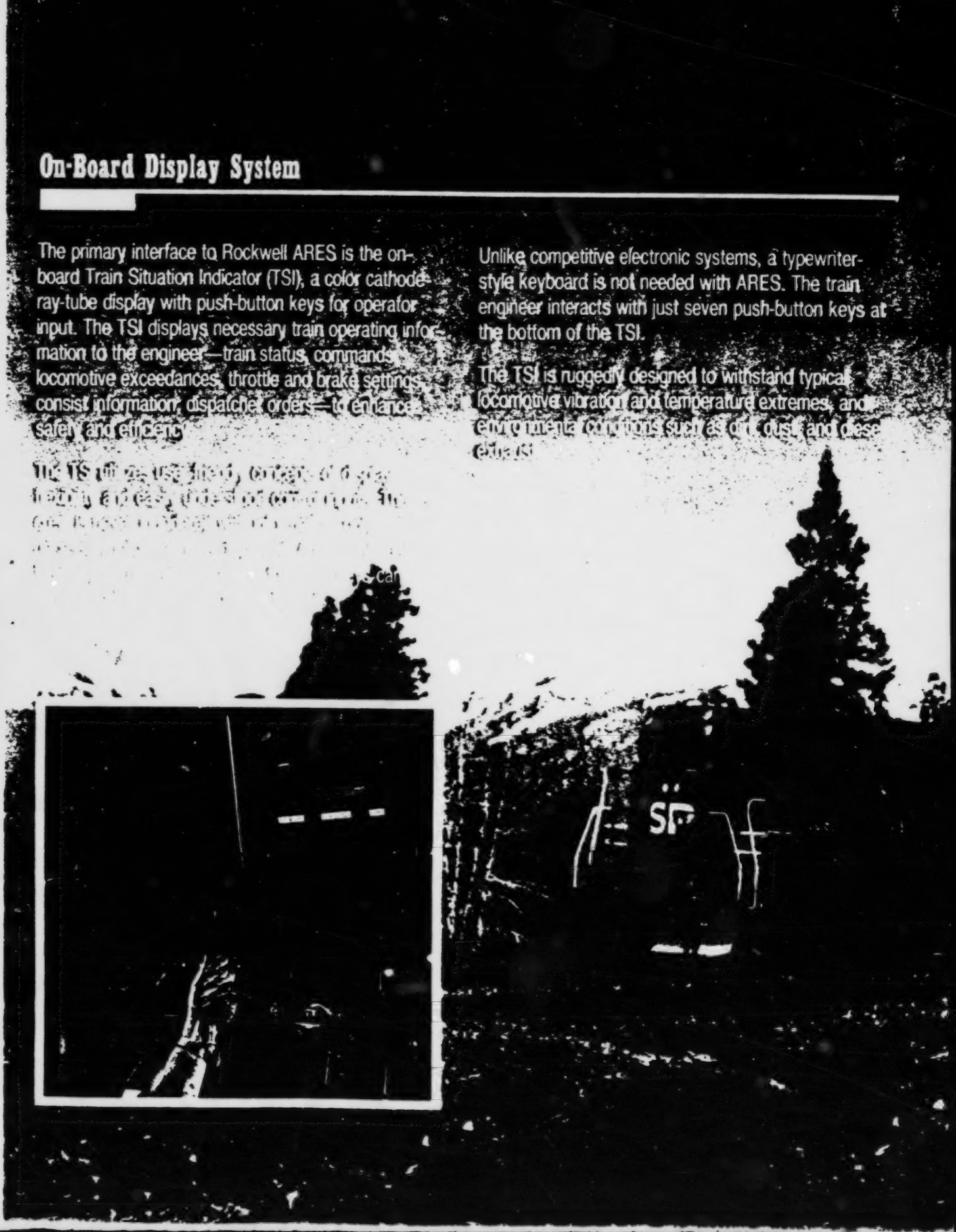
The LARS also provides real-time fuel system monitoring, including current quantity on-board, low fuel warning, and data on the last six refueling stops with time, date, and quantity added.

On-Board Display System

The primary interface to Rockwell ARES is the on-board Train Situation Indicator (TSI), a color cathode ray-tube display with push-button keys for operator input. The TSI displays necessary train operating information to the engineer—train status, commands, locomotive exceedances, throttle and brake settings, consist information, dispatcher orders—to enhance safety and efficiency.

Unlike competitive electronic systems, a typewriter-style keyboard is not needed with ARES. The train engineer interacts with just seven push-button keys at the bottom of the TSI.

The TSI is ruggedly designed to withstand typical locomotive vibration and temperature extremes, and environmental conditions such as dirt, dust, and diesel exhaust.



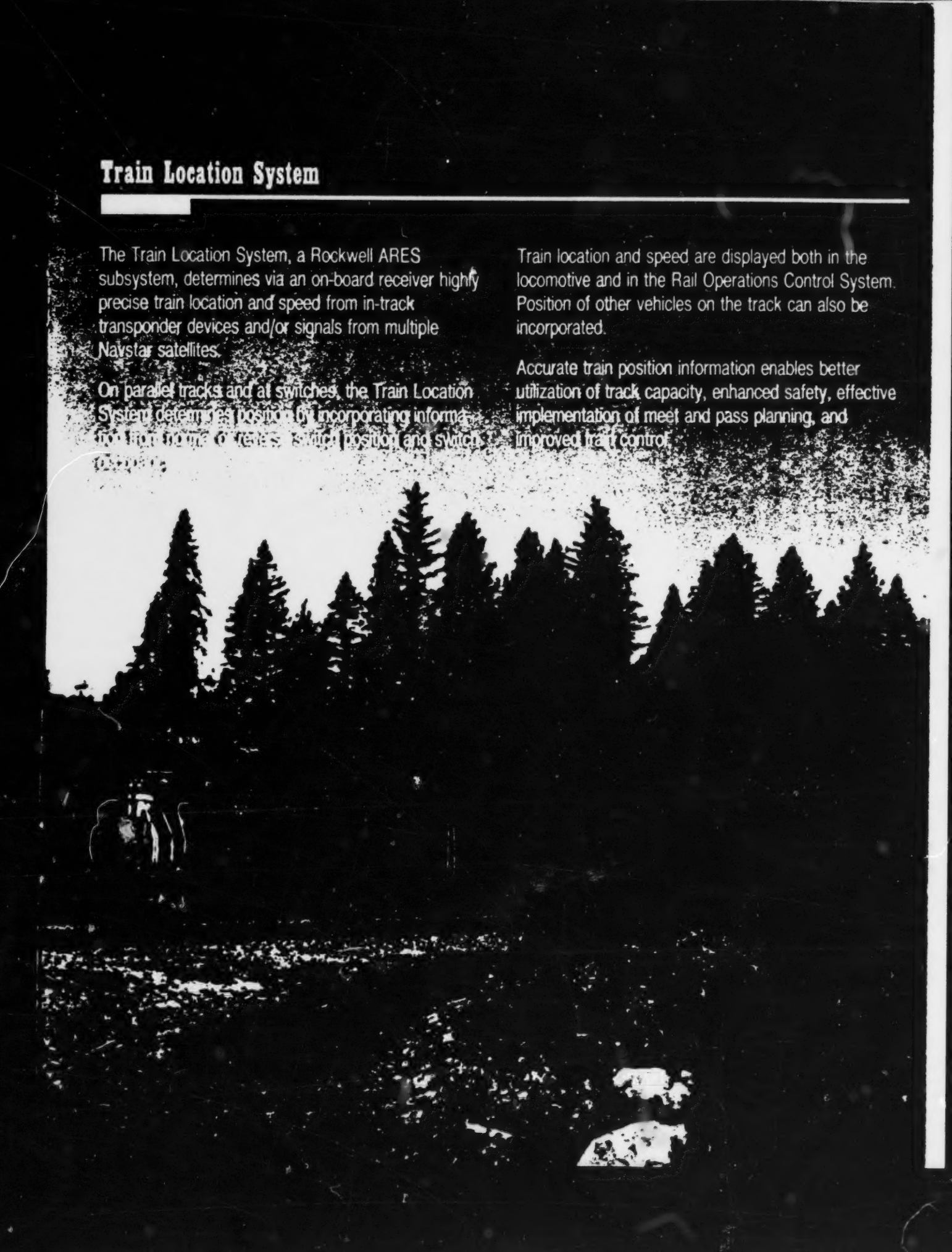
Train Location System

The Train Location System, a Rockwell ARES subsystem, determines via an on-board receiver highly precise train location and speed from in-track transponder devices and/or signals from multiple Navstar satellites.

On parallel tracks and at switches, the Train Location System determines position by incorporating information from [illegible] position and switch [illegible].

Train location and speed are displayed both in the locomotive and in the Rail Operations Control System. Position of other vehicles on the track can also be incorporated.

Accurate train position information enables better utilization of track capacity, enhanced safety, effective implementation of meet and pass planning, and improved train control.



Energy Management System

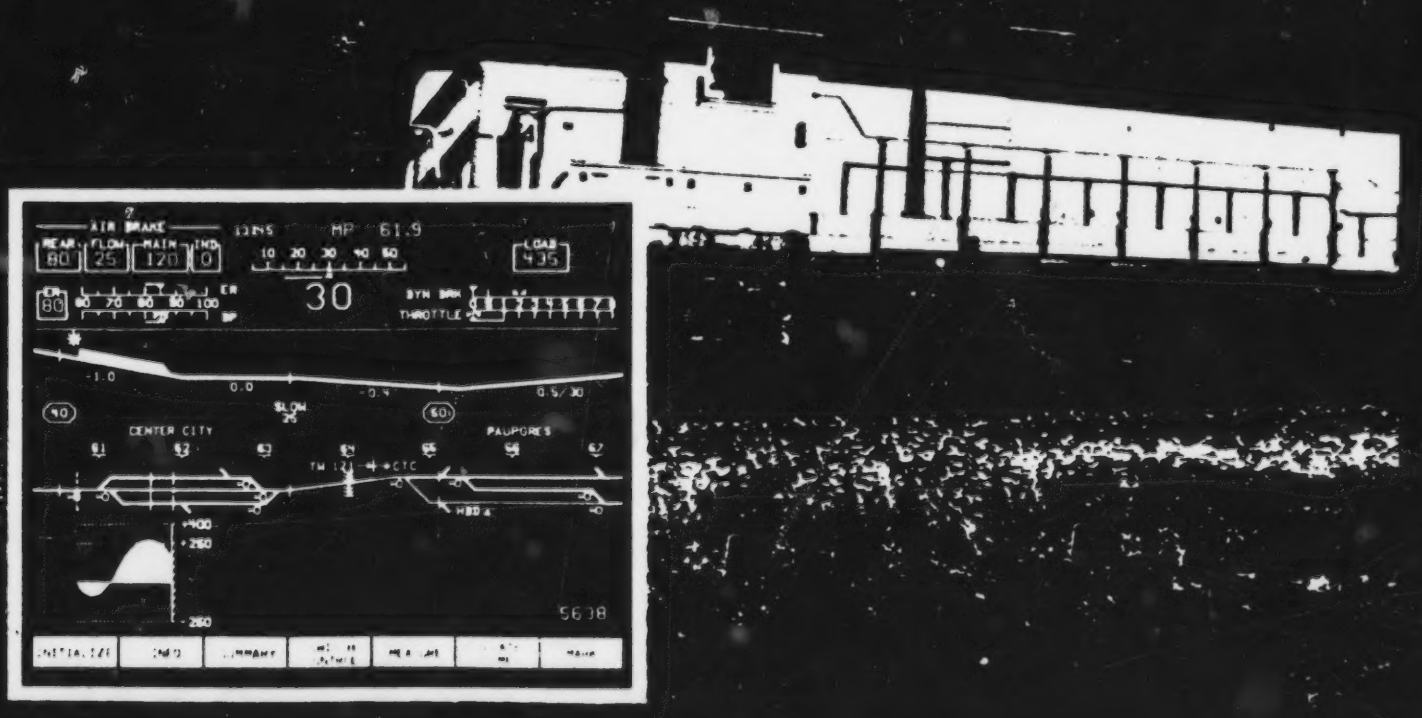
The Energy Management System, a subsystem of ARES, provides for energy-efficient control of the train consistent with all requirements for safety and schedule performance. The system is automatically supplied, via the data network, information on track profile, speed limits, schedules, consist profile, motive power, and special conditions such as slow-orders. It then determines what amount of energy is required to meet the schedule at the lowest fuel consumption consistent with good train handling techniques.

The Energy Management System computer constantly assesses the territory the train will be operating over as well as the forces acting on the train to determine whether a curve, grade, or speed restriction should be considered to alter the present energy input. The calculations are based on a trade-off between energy costs and time costs and are calculated in real time by the onboard Energy Management Processor.

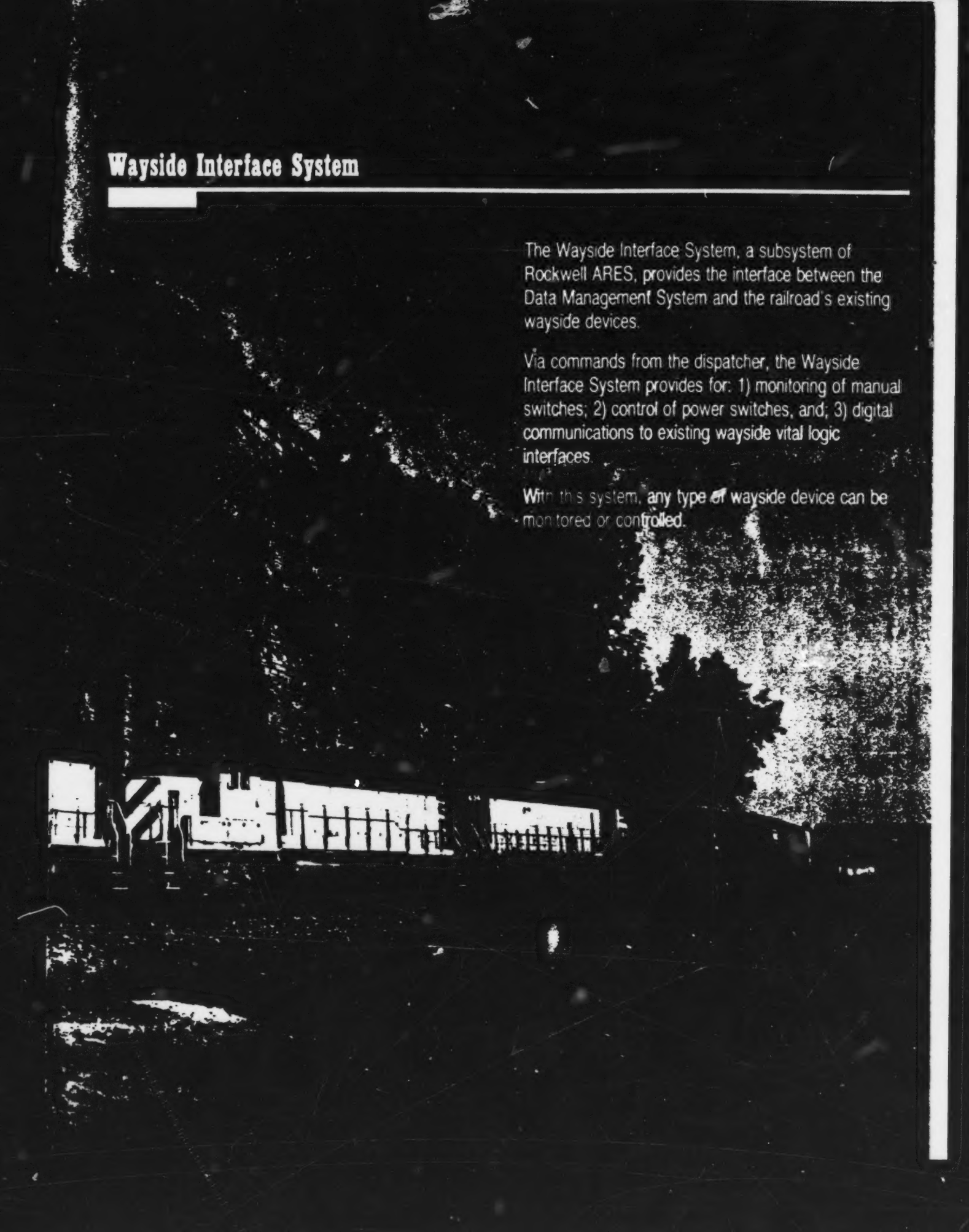
Computed throttle and brake outputs are sent directly to the train situation indicator and displayed as commands to the engineer. Also displayed on the TSI are speed, system mode status, and position of the train relative to the track profile.

If full available power is not required, the system uses a power allocation mode to idle the least efficient locomotive.

In summary, the Energy Management System evaluates all available data to reduce costs, increase safety, and improve train handling.



Wayside Interface System



The Wayside Interface System, a subsystem of Rockwell ARES, provides the interface between the Data Management System and the railroad's existing wayside devices.

Via commands from the dispatcher, the Wayside Interface System provides for: 1) monitoring of manual switches; 2) control of power switches, and; 3) digital communications to existing wayside vital logic interfaces.

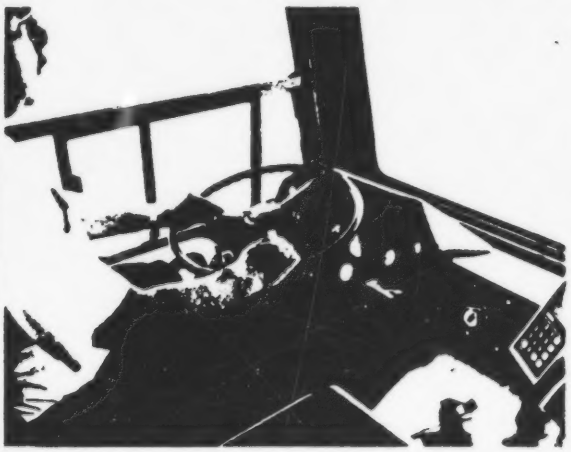
With this system, any type of wayside device can be monitored or controlled.

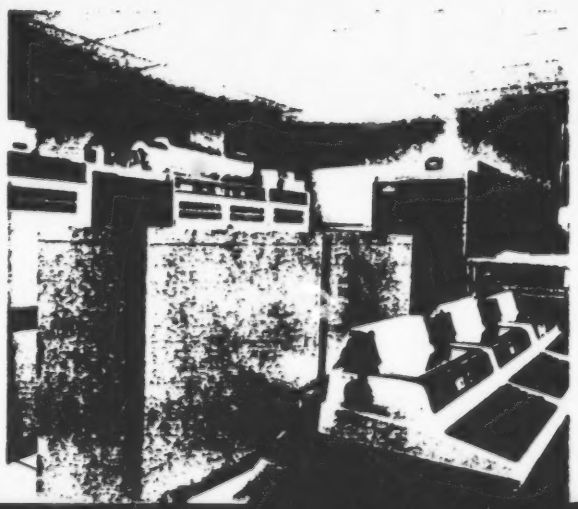
APPENDIX - II: Electronics in Automotive Industry

TRANSIT MASTER™

FLEET MANAGEMENT, COMMUNICATION AND CONTROL SYSTEM

GRS





INTRODUCTION

GRS Transit Master Systems offer new, higher levels of communications, that provide communication and control for all types of vehicle fleets.

The Transit Master Fleet Management, Communication and Control System locates and monitors vehicles, gives accurate, real time information, and provides instant dispatcher control using state-of-the-art two-way data/voice radio communications.

This unique combination of real time information with instant data and voice communications means faster response to changing conditions, better decisions, more efficient operation ... *and improved driver protection.*

Transit Master also provides the management information and reports needed to evaluate and streamline fleet performance.

System components are rugged, compact, and meet Mil. Spec. 810D. Using the latest microprocessor and data/voice communications technology, Transit Master components can be configured to meet the needs of almost any system. You specify: the type of data to be collected and how it will be used, the central office display and the required management reports.

And Transit Master is flexible, adapting easily to changes in route schedules, route structures, vehicle changes and changes in vehicle or personnel assignments.

This level of communications provides communications and control capabilities that have never been available before. The benefits include: better fleet performance, increased fleet productivity, reduced operating costs, outstanding flexibility in your fleet management procedures and added safety through better communications.

Transit Master Systems from GRS: A new, higher level of communication, and control... a new, cost-effective, fleet management tool for you!

GENERAL DESCRIPTION

Each Transit Master System integrates four operating subsystems:

- Communications - Voice and Data
- Data Collection and Monitoring
- Automatic Vehicle Location
- Central Office Processing and Display

A variety of options is available within each of these subsystems, including a comprehensive Reporting Capability for management information and analysis.

COMMUNICATIONS - VOICE AND DATA

The Transit Master System maintains voice and data communications links between vehicles and the central office via a sophisticated two-way data/voice radio system.

The dispatcher can send voice or data communications to the entire fleet, to selected vehicles, or to a single vehicle. *The only exception is in an emergency situation. This prevents the dispatcher from inadvertently communicating by voice to a vehicle.*

In addition to the data sent by data communication channels, the driver has 3 types of request for radio communications with the central office:

- Driver Request To Talk -- voice
- Driver Priority Request To Talk -- voice
- Emergency Alarm -- silent

Driver Display Unit. The driver display unit is a microprocessor-based, keypad-equipped, driver/dispatcher communications link, with a 6-digit code capability.

Messages transmitted to the driver or dispatcher are displayed on its easy to read LCD screen. These messages include a continuous display of schedule adher-

ence expressed in minutes and seconds. The unit is used by the driver to communicate necessary information to the central office. This information includes: driver identification, vehicle and route numbers, start times, and requests to talk. An armored cable handset is provided for direct voice communications by the driver.

DATA COLLECTION AND MONITORING

Vehicle Logic Unit. Information gathering and transmission at the vehicle is controlled by a vehicle-mounted logic unit. This unit receives, communicates and stores data. Its basic functions include vehicle location (data receipt and data format) and driver communication (Driver Request To Talk, Driver Priority Request To Talk, and a silent emergency alarm).

In addition to these basic functions, its modular design expands easily to accommodate a variety of additional optional functions. These include:

- Destination Sign Control
- Passenger Counting. Via treadle mounts in step walls or ultrasonic sensors.
- Farebox Information. Via interface with farebox systems.

Automatic Vehicle Location. Vehicle location is determined by a Locating Signpost (which sends a coded signal through a vehicle mounted transceiver to the dispatch center).

Battery-powered (5-year life) and weather resistant, the field-programmable locating signpost can accurately pinpoint vehicle locations at speeds up to 65 mph. When a signpost code is received by the vehicle, the central office is automatically notified; thus, determining the vehicle's location.

Mechanical Alarm Sensors. The Vehicle Logic Unit can monitor up to six mechanical sensors, which constantly check on vehicle operating conditions, e.g., vacuum, air conditioning, oil pressure, cooling, etc). Information collected by these sensors is automatically transmitted to the central office.

CONTROL OFFICE: COMMUNICATIONS AND CONTROL!

This subsystem supplies the real time information used by the dispatcher to control the fleet, issue commands, manage day-to-day operations, and resolve problems. It uses state-of-the-art, 32-bit processors for data encoding and decoding, and operates on specially designed FORTRAN or C software.

Dispatcher information is displayed on black & white or optional color tabular display screens in the central office. Vehicle location can be displayed in a tabular format or, optionally, on color displayed route maps.

In most cases, information is displayed on an "out of tolerance" exception basis, so the dispatcher does not have to monitor all fleet activities to be aware of potential problem situations.

The dispatcher can call up this "exception" information for selected routes, individual vehicles, or for the entire fleet. Complete information on all fleet activities is also available on request.

Real time information available to the dispatcher includes:

- Vehicles with equipment malfunctions.
- Vehicles exceeding pre-established "exception" limits:
  - Schedule tolerances
  - Stopped Bus
  - Off-route
  - Headway Bunching
  - Vehicles not within a specific percent of load capacity. (with PCS option)
  - Vehicles with emergency status.*
  - Vehicles Requesting To Talk.*
  - Vehicles with Priority Request To Talk.*

* *Queued in a separate area of the display screen.*

Color Graphic Display. A powerful "command and control" option provides a color display consisting of geographic route maps of the controlled area. Vehicle location-on-route, for any specified route, can be displayed as well as specific information about each vehicle. This dynamic data display, updated every minute, shows vehicles color coded as:

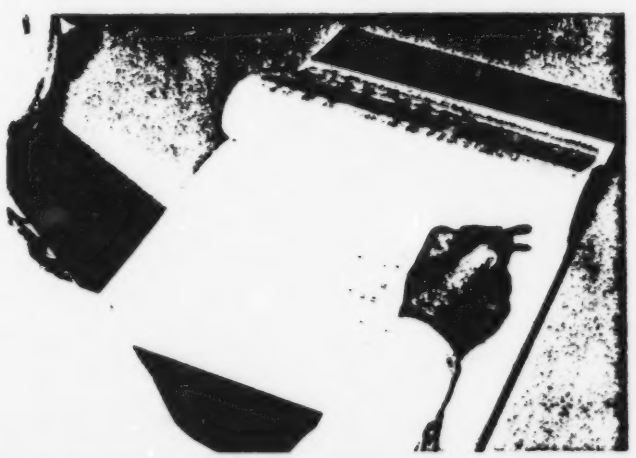
- Normal
- In Emergency
- Stopped
- Very Late
- Late
- Early
- =/- Specified % Passenger Capacity

Management Information. Transit Master reporting capabilities provide a valuable operating and management tool.

The system can store operating data, format it, and generate and present reports on request. This makes it possible to develop effective management information and analysis tools specifically tailored to your needs.

Available report formats include:

- Schedule Deviation Reports
- Performance Reports
- Ridership Performance Reports
- Recall Report (Malfunctions and alarms)
- Mobile Activity
- Alarm Activity
- Dispatcher Activity
- ***And other reports to your specifications!***



DETAILED DESCRIPTION OF SYSTEM COMPONENTS

VEHICLE LOCATING SIGNPOST

The vehicle locating signpost accurately pinpoints the location of vehicles moving at speeds of up to 65 mph. The unit automatically sends its coded identification (ID) to the vehicle's logic unit for transmission to the dispatching control center.

Features

- FCC type accepted and licensable
- Provides fixed location ID to vehicles
- Jumper programmed for ID's between 1 and 9999
- High security coding resists interference
- Weather-resistant in all climates
- Low power consumption
- Easily serviced without removal from pole
- Rugged cast aluminum housing

Specifications

Physical

- 5 3/4" x 5 3/4" x 2 1/2"
- Weighs 2.5 pounds
- Mounts to metal, concrete or wood poles with fasteners or strap
- 10" flexible antenna

Electrical

- I mW output power
- Duty cycle 2% or less
- Powered by 6-volt lithium cells with a 5-year life
- Battery status indication - transmitted with ID

Operational

- Range of 150' - 250' radius, mounted 15 ft. above highway
- ID code field programmable
- Vehicle detection at speeds to 65 mph
- Transmit output level field adjustable
- -40°C to +60°C
- Operates on 44-45 MHz

Options

- 120-volt, a-c powered version available
- 10- year life batteries

DRIVER DISPLAY UNIT

The unique driver display unit permits the driver to exchange a broad variety of operating data with the dispatching control center. The unit has a custom liquid crystal display for the driver to monitor data entries.

Features

- Simplified operator entry of data
- Easy to read alphanumeric display
- Lighted display for night viewing
- Time displayed for operator reference
- Located within easy reach of driver
- Handset with armored cord
- Remote diagnostic terminal plug
- Convenient size for easy mounting

Specifications

Physical

- 9"H x 4 1/2"W x 2"D
- Weighs 3 pounds
- Splashproof/tamper-resistant
- Meets EIA RS-374A shock/vibration

Electrical

- All solid-state (CMOS)
- Single cable connection
- Microprocessor controlled
- Custom liquid crystal display
- Built-in power regulation for increased reliability

Operational

- Displays all entries, with dual acknowledge for both local and central
- Memory retains route/run, time, badge, and schedule adherence
- 16 keys for inputs, audio feedback
- Sends special codes of up to 6 digits
- Audible alert tones for calls
- Displays schedule adherence in minutes/seconds
- Controls PA system

VEHICLE LOGIC UNIT

The vehicle logic unit is easily expandable to include optional functions such as: vehicle location, destination sign control, passenger counting and farebox monitoring The module has circuit board slots for optional functions. Full data control of the mobile radio is included.

Features

- Provides radio control, vehicle location and data acquisition for up to 6 mechanical sensors
- Optional passenger counting, farebox data interface, destination sign control
- Rugged module, installs out of sight, houses all options
- Companion driver display unit for operator
- Covert emergency alarm

Specifications

Physical

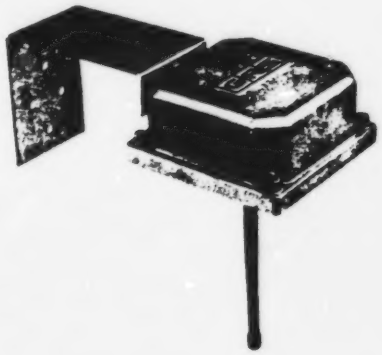
- 15"L x 10"H x 6"W
- Weighs 15 pounds
- Meets EIA RS-374A specifications/MIL STD-810C (shock & vibration)
- Splash-resistant/tamper-resistant
- Modular construction: all active equipment on removable PC boards

Electrical

- All CMOS logic and CMOS microprocessor
- Uses 12 VDC (1/2 amp maximum current)
- Monitors up to 6 sensors, plus odometer, emergency switch, and ignition
- Built-in active vehicle location system receiver
- EMI/RFI protected

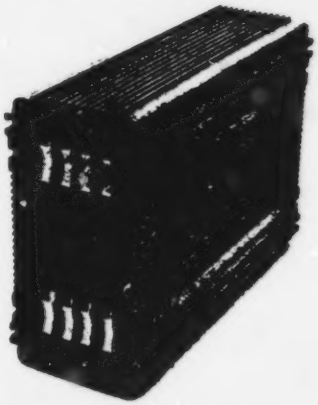
Operational

- Compatible with 2-way mobile radios
- Internal volume and squelch settings
- Built-in PA system control
- Fully secure data transmission (1200 baud) over ordinary 2-way radio channels
- Fallback operation if either central control or onboard units should fail



Vehicle Locating Signpost.

Driver Display Unit.



Vehicle Logic Unit.

NEWS FROM GRS

GENERAL RAILWAY SIGNAL
A UNIT OF GENERAL SIGNAL
PO BOX 20600 ROCHESTER NY 14602-0600
716 436-2020

SAM M. LATONE
VICE PRESIDENT - MARKETING

FOR RELEASE:

March 7, 1988

General Railway Signal Co. (GRS) of Rochester, NY, announces that the board of the Southern California Rapid Transit District (SCRTD) of Los Angeles, CA, has voted to award the first phase of a 29 plus million dollar transit radio system contract to GRS.

In announcing the vote, Sam Latone, GRS vice president of Marketing, said the contract is subject to approval by the Urban Mass Transportation Administration (UMTA) in Washington, DC. The contract starting date is dependent upon UMTA approval and installation will take approximately two years to complete.

GRS's Transit Master™ Bus Management and Communication System will provide SCRTD with vehicle location information, radio communication between vehicles and the central control center, more efficient scheduling of routes, and an emergency communication network for transit police, or other services.

The data collection system will record such information as passenger counting, vehicle location, farebox data, mechanical alarms, emergency alarms, and routing information, sending it all to the central control center.

APPENDIX - III: Electronics in Shipping Industry

SECTION 1

GENERAL INFORMATION

PURPOSE OF MANUAL

1.1 This manual provides a general description, operating instructions, theory of operation, maintenance procedures, special procedures, installation instructions, parts list and diagrams for the Remote Control and Monitor (RCM) Group which forms part of Vessel Traffic Management System (VTMS) installed at Vancouver, British Columbia.

Reference Publications

1.1.1 The following publications provide further information on the VTMS:

(1) Vessel Traffic Management System, Vancouver, System Maintenance Manual, Leigh Instruments Ltd.

(2) Vessel Traffic Management System, Vancouver, Equipment Maintenance Manual, Distribution Group, Leigh Instruments Ltd.

(3) Vessel Traffic Management System, Vancouver, Equipment Maintenance Manual, Video Recording Group, Leigh Instruments Ltd.

(4) Vessel Traffic Management System, Vancouver, Equipment Maintenance Manual, Central Processing Group, Leigh Instruments Ltd.

(5) Regulated Power Supplies (various), Lambda Electronics.

(6) VTMS Radar, Volume III, Remote Site Installation and Maintenance Part 1 — Installation and Maintenance AIL Division of Cutler-Hammer (P152-H-4).

(7) VTMS Radar, Volume III, Remote Site Installation and Maintenance Part 2 — Circuit Diagrams, AIL Division of Cutler-Hammer (P-151-H-5).

(8) VTMS Radar, Volume II Operations Center Installation and Maintenance Instructions Part 1 — Installation and Maintenance, AIL Division of Cutler-Hammer (P-151-H-2).

(9) VTMS Radar, Volume II Operations Center Installation and Maintenance Instructions Part 2 — Circuit Diagrams, AIL Division of Cutler-Hammer (P-152-H-2).

(10) Instruction Manual for Scanning System Supplied To Farinon Electric Limited — Vessel Traffic Management, S-8000 July 1976, Quindar Products Ltd.

Abbreviations

1.1.2 Wherever possible, abbreviations used in this manual are in accordance with MIL-STD-12C. Abbreviations peculiar to VTMS are listed in the Glossary.

Symbols

1.1.3 Graphic symbols used in electrical and electronic diagrams in this manual are in accordance with ANSIY32.2, CSA Z99 and IEEE Std 315-1975.

PURPOSE OF RCM GROUP

1.2 The RCM Group includes that equipment that enables Operations Centre personnel to control and monitor remote radar and video transmission equipment and to receive alarms from video and message transmission equipments and certain remote and local site facilities.

GENERAL DESCRIPTION

1.3 RCM equipment consists of the following:

(1) Control, monitor and alarm annunciator panels, mounted on six consoles in the Operations Centre at Kapilano. There are four Regulator consoles, one Supervisor console and one Maintenance console. The names of the panels and the consoles on which they are mounted are listed in Table 1-1.

Panel Name	Quantity	Location	Illustration
Radar Control and Monitor Panel	4 (6)*	One on each Regulator console	Figure 8-1
Alarm Annunciator Panel Regulator	4 (6)*	One on each Regulator console	Figure 8-2
Radar Monitor Panel	1	Supervisor console	Figure 8-3

Table 1-1. (Sheet 1 of 2) RCM Panels in Consoles at Operations Centre, Kapilano

Panel Name	Quantity	Location	Illustration
Alarm Annunciator Panel Supervisor	1	Supervisor console	Figure 8-4
Alarm Annunciator Panel Maintenance	1	Maintenance console	Figure 8-4
Protection Override Panel	1	Maintenance console	Figure 8-5
* Number in parentheses for future expansion.			

Table 1-1. (Sheet 2 of 2) RCM Panels in Consoles at Operations Centre, Kapilano

(2) A Logic Rack Assembly and Power Supply, mounted in the Maintenance console.

(3) Quindar scanning equipment in the Equipment Room at Kapilano and at each remote site. This equipment scans all signals resulting from control commands, status information and alarm conditions, processes these into appropriate serial digital format, and delivers them to the VTMS Message System. The Message System provides a radio communication link between Kapilano and the remote sites.

Radar Control and Monitor Panel

1.3.1 There is a Radar Control and Monitor Panel on each of the four Regulator consoles. There are four Remote Radar Sites, one at each of the following locations: Mount Helmcken, Mount Newton, Mount Parke and Bowen Island. Each Regulator console is dedicated to controlling and monitoring the equipment at one of these sites.

Controls and indicators on the Radar Control and Monitor Panel enable the Regulator to control the operation of radar equipment at the dedicated remote site and to monitor the status of that equipment.

Alarm Annunciator Panel Regulator

1.3.2 There is one such panel on each Regulator console. It provides indication of alarm conditions at the dedicated site.

Radar Monitor Panel

1.3.3 There is one Radar Monitor Panel, on the Supervisor console. This panel is identical with a Radar Control and Monitor Panel Regulator, except that it also provides a RADAR SITE MONITOR selector switch. This switch enables the Supervisor to monitor the operation of radar equipment at any one of the four radar sites.

Although the panel provides control switches as on each Regulator panel, in normal operation of the system these switches do not function, and control of each radar site is effected only at the dedicated Regulator console. Thus the Supervisor panel provides facilities only for monitoring.

However, the Supervisor panel may be reconfigured such that it provides control and monitoring facilities for one selected site. In the reconfigured mode, the Supervisor panel functions as the Control and Monitor Panel for the selected site, and the panel on the Regulator console for the selected site can only monitor. Also, in this mode the Supervisor cannot monitor any other site.

Alarm Annunciator Panel Supervisor

1.3.4 The Alarm Annunciator Panel Supervisor provides visual and aural indication of alarm conditions that may occur anywhere in the Vessel Traffic Management System. LED indicators on the panel provide visual indications of fault conditions in radar video equipment and message equipment at Kapilano, Helmcken, Newton, Parke, Bowen and a Repeater Site at West Vancouver. LED indicators also provide visual indication of faults within the RCM equipment as detected by a self-monitoring facility, and local alarm conditions at each site.

When any alarm condition is detected and visually displayed on the panel, a Sonalert alarm that is built in to the panel is sounded.

Alarm Annunciator Panel Maintenance

1.3.5 This is an exact duplicate of the Alarm Annunciator Panel Supervisor. It provides the same facilities.

Protection Override Panel

1.3.6 This panel is located on the Maintenance console. Throughout the VTM System, all transmitting and receiving equipment is duplicated. For each transmitting and receiving function, there are two identical sets of equipment, designated A and B respectively. If A is on line (operating), B is either in standby mode (ready to operate) or maintenance mode (under repair). If, while B is in standby mode, a fault develops in A, then B is automatically switched to on-line mode and A is designated as in maintenance mode. On the other hand, these roles for A and B may be reversed.

During maintenance procedures involving video transmitters or receivers, it may become necessary to override this automatic selection of A or B for operation on line, and force a deselected set of equipment back on line. The Protection Override Panel provides facilities for this purpose.

To minimize unauthorized use of the facility, operation of the Protection Override Panel is controlled by a key-operated switch.

Logic Rack Assembly

1.3.7 Electronic circuits contained on circuit cards housed in the Logic Rack Assembly perform the following functions:

(1) Classification of incoming alarms and routing of alarm circuits to appropriate annunciator panels.

(2) Generation of a special RCM self-test activity to monitor the operation of RCM equipment, including the transmission of signals via Quindar equipment and the Message System to and from remote sites.

(3) Processing of all incoming alarms into appropriate code numbers in serial digital format for application to a logging facility in the Central Processing Group.

Quindar Equipment

1.3.8 A brief description of the operation of Quindar equipment and interpretation of indications on Quindar panels are given in Section 3 of this manual. For further details, refer to Instruction Manual for Scanning Systems Supplied To Farinon Electric Limited — Vessel Traffic Management System, S-8000 July 1976, Quindar Products Ltd.

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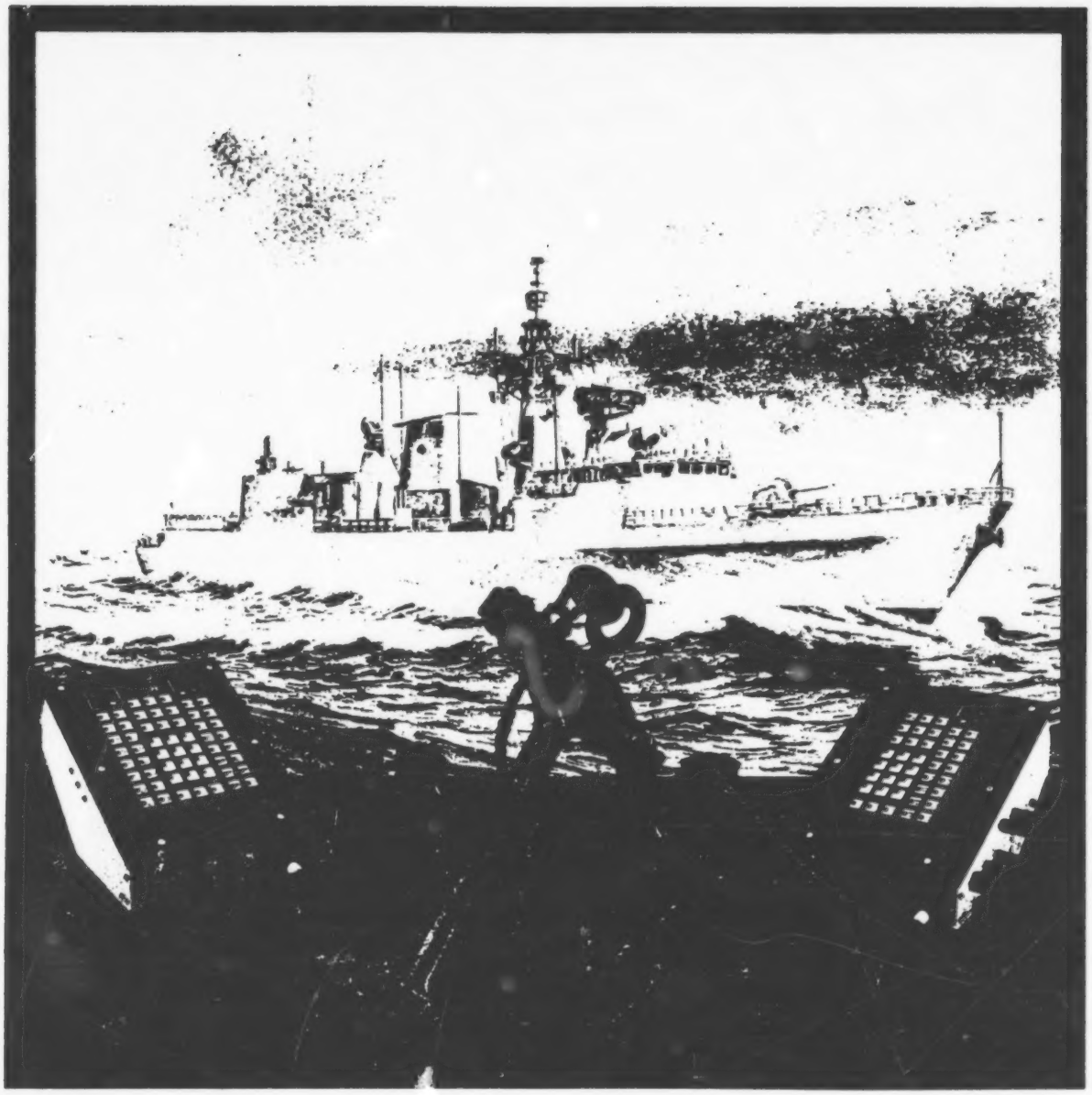


AN/SSC-502(V)
INTEGRATED COMMUNICATIONS SYSTEM

The key to effective shipboard command and control

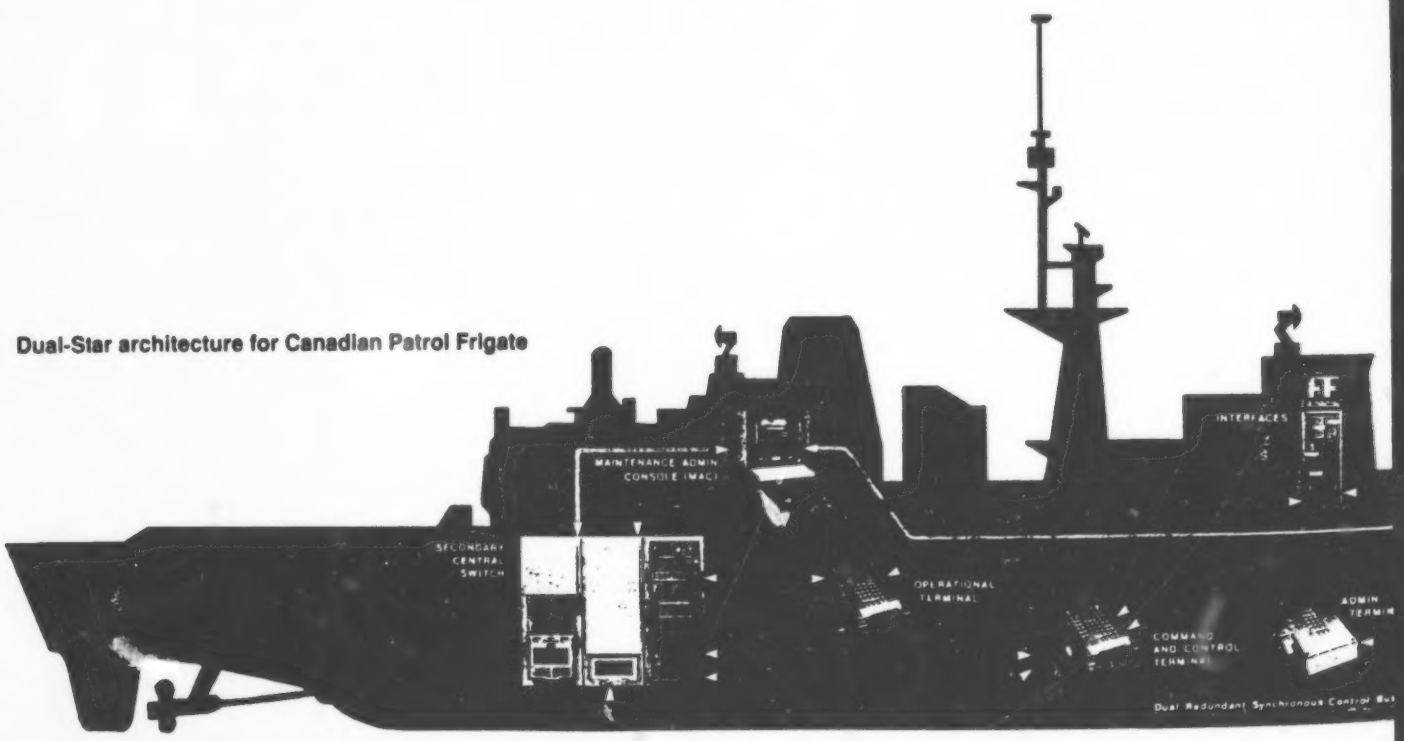
A warship's internal communications system is the key to effective internal command and control. Fast, highly reliable and survivable communications are essential to mission performance, particularly under combat conditions.

Leigh has developed state-of-the-art integrated communications systems, in co-operation with the Canadian Navy, which meet the most demanding requirements of modern warships.

Our AN/SSC 502(V) (SHINCOM*) system has been selected for the Canadian Navy's new frigates and the Tribal Class Modernization Program. A variant known as REMSEVS is in production for retrofit to existing Canadian warships. The compact version, which is now available, is specifically designed to meet the special needs of smaller warships and submarines.

- **Survivable**
  Built-in redundancy prevents loss of vital communications in the event of component failure, battle damage or power failure.
- **Reconfigurable**
  The system can be rapidly reconfigured at sea to satisfy changing operational requirements or to bypass out-of-action stations in case of battle damage, fire or flooding.
- **Secure**
  Voice signals are digitally encoded at the terminal and system interfaces, and switched and transmitted throughout the ship. The total system is designed to meet current TEMPEST standards.

* DND trademark



Dual-Star architecture for Canadian Patrol Frigate

- **Expandable**
  Design of the switching network enables the system, including line cards and interfaces, to be configured to the specific size and operational requirements of the ship. Leigh systems are modular, which means that the configuration can be rapidly implemented to address a wide range of operational requirements and to allow cost-effective system expansion, if needed.

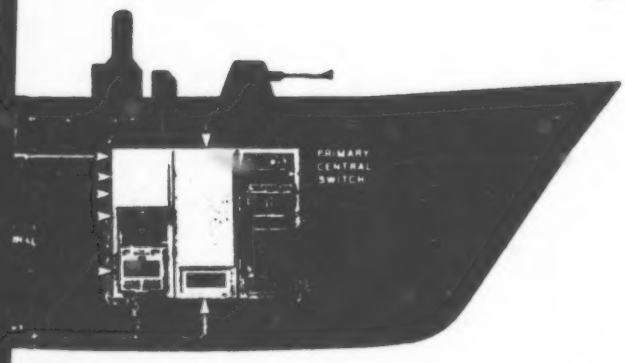
Remote Control Secure Voice System configuration

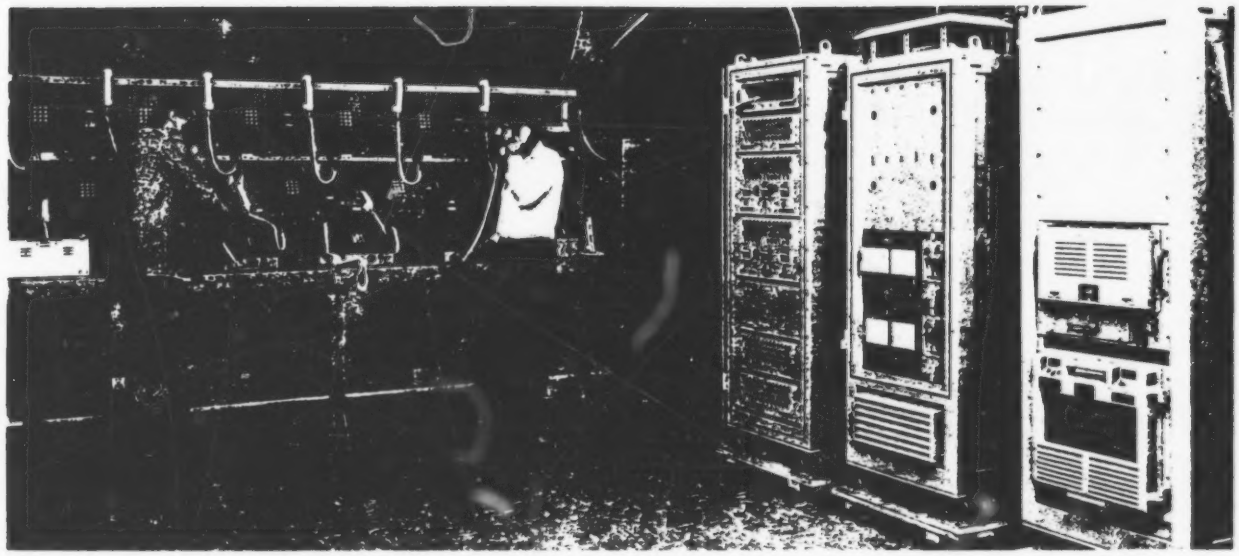
- **Reliable**
  High reliability is achieved through the use of proven components, call and processing techniques, system design and built-in redundancy.

- **Conferencing**
  The system design permits extensive conferencing and networking capability. Conferences can be pre-programmed for known operational roles, or rapidly established through the add-on-conference or meet-me-conference features.

- **Diagnostic maintenance**
  Run on-line with operational software for comprehensive hardware fault detection. Off-line diagnostics are also available.

- **Operational flexibility**
  Leigh integrated systems are based on a modular, standard 19 inch shelf design. They can be used in applications ranging from a complete shipboard voice communication network to a secure switch for interface to plain and encrypted radio. The system can be configured also for ground-based installations with high security requirements.





System in Factory Acceptance Test

Dual switch configuration

The system can be configured in a redundant, dual-star architecture to prevent the loss of vital communications in the event of damage to, or failure of any component or system assembly.

The redundancy is achieved by providing two physically-separated central switches (designated primary and secondary), to which all vital terminals and interfaces are linked. The Central Processor Units (CPU) of the two central switches are interconnected to allow the secondary switch to assume control functions in the event of a primary switch failure.

The Control Group

The Central Processor Unit (CPU) is the heart of the control group and is responsible for system processing, including assembling and allocating switching resources to satisfy communication requirements. The resident mass storage contains the software necessary for call processing, maintenance and diagnostics, inter-computer communications and data base administration.

The Network Group

Under the control of the CPU, the Network Group detects the communications requirements and allocates the necessary switching resources. The network also distributes speech signalling information to the terminal and interface groups, provides conference capability, and generates the audio tones required for system operation as well as visual and audible alarm indications.

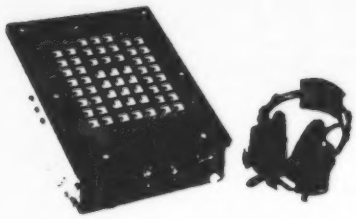
The Power Group

Power conversion equipment transforms the primary supply to the voltages and frequencies necessary for the system operation. A microprocessor-based controller monitors power system performance, ensures controlled start-up, and maintains the emergency battery backup system.

System Capacities

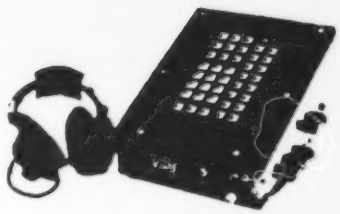
The modularity of the system enables it to be tailored for a variety of line size requirements in a range of shipboard applications. For line sizes of 48 or less, such as in fast patrol boats and submarines, a single shelf central switch is provided. This shelf can be mounted in any standard 19 inch rack or in a stand-alone cabinet 48 inches in height. Additional modules can be added as required up to a maximum capacity of 224 lines based on two stand-alone cabinets each 48 inches high.

For applications with line size requirements between 224 and 416 lines, the central switch is installed in a standard 72 inch high cabinet with a separate cabinet housing the power group. In all cases, the system can be configured for full redundancy by duplicating the central switch.



Administrative Telephone Controller

- Each controller supports 8 standard administrative telephones
- Provides limited access to the system for non-vital locations (e.g. cabins, ship's offices)
- Accepts commercial type telephone sets



Command Terminal

- Dual channel
- Duplicated access
- Independent access to each channel
- Six feature keys
- Dual dial digit display
- 28 programmable keys
- Local audio control
- Dimmer
- Headset or handset

Outdoor operational terminal

- A watertight enclosure is provided for the Operational Terminal for exposed locations

Operational Terminal

- Duplicated access
- Six feature keys
- 16 programmable keys
- Digit display panel
- Local audio control
- Dimmer
- Headset or handset

The Leigh system interfaces to:

Radio transceivers	Sound powered telephone networks	Helicopter intercom
Cryptographic equipment	Underwater telephone	Flight deck broadcast
Public address (main broadcast)	Loop start trunks (shore lines)	Voice recorder

System/terminal features are:

Normal (dial) call	Call forward	Call forward no answer
Abbreviated dialing	Call back	Auto answer
Pre-arranged conference	Hold	Over-ride
Add-on-conference	Voice call	Emergency public address
Meet-me conference	Call park	Emergency directory number
Call transfer	Call waiting	Record

General specifications

Technology:	Microprocessor controlled digital switch
Switching:	Time division multiplexing (TDM)
System capacity:	Up to 416 lines with 48 line shelf modularity
Qualified to:	MIL-E-16400 MIL-STD-1472 MIL-STD-461 MIL-STD-810
Designed to:	NACSIM 5100A (TEMPEST)
Frequency response:	300 to 3400 Hz
Operating temperature:	-28°C to +65°C (unsheltered equipment)
Primary power:	440 VAC 3 phase or 115 VAC angle phase or 28 VDC Battery backup available
Terminal dimensions:	12 x 10 x 13 inches
Cabinet dimensions:	72 x 24 x 26 inches or 48 x 24 x 26 inches
Modular shelf:	19" EIA Standard
Crosstalk:	Greater than 110 dB isolation

Our credentials

Leigh has over a quarter of a century of experience in the design, development, production and in-service support of high performance, high quality electronics equipment. We are a major supplier to aerospace, government and military customers around the world.

In addition to the secure, integrated communications equipment described in this brochure, our systems capabilities include aircraft navigation aids such as TACAN beacons, Microwave Landing Systems, Distance Measuring Equipment and Shipborne Aircraft Landing Systems.

Our aerospace products demonstrate a leadership in developing unique avionics such as deployable airfoil flight recorder/locator systems and helicopter ice detection systems.

All Leigh equipments are designed and manufactured to meet severe survivability and environmental standards. All aspects of the manufacturing process are overseen by a military standard quality assurance program that delivers high quality and reliable products to our customers. Our Integrated Logistics Services group ensures that each product is maintained throughout its useful life at the lowest life cycle cost.

LEIGH

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APPENDIX - IV: Electronics in Airspace Industry

Department of Transport
Facility Engineering and Systems Development Branch

Ministère des Transports
Direction de l'ingénierie des installations et
de la mise au point des systèmes

FESD
MAINTENANCE REQUIREMENTS
AIR NAVIGATION SERVICES

EXIGENCES D'ENTRETIEN DE L'IIMS
SERVICES DE LA NAVIGATION AERIENNE

TP 8537

FESD MAINTENANCE REQUIREMENTS.....RMM ENVIRONMENT

INTRODUCTION

The purpose of this section is to describe the maintenance requirements associated with the introduction of automation to gather operational data and to extend remote monitoring, control, and diagnostic appraisal to the maintenance of electronic and electrical systems and equipment.

REMOTE MAINTENANCE MONITORING (RMM) OBJECTIVES

FESD Branch objectives are:

- To reduce the cost of maintenance;
- To increase the effectiveness and efficiency of maintenance.

RMM will support these objectives by:

- Reducing the frequency of site visits;
- Providing potential for more centralization of the work force;
- Facilitating access to records, equipment histories, and technical assistance as required;
- Simplifying system/equipment certification procedures;
- Increasing system availability;
- Reducing paper work through automation.

CONSTRAINTS

The degree to which RMM objectives can be implemented will be influenced by the host system/equipment requirements such as integrity, reliability, and security. Where RMM objectives cannot be met without compromising these requirements, the host system/equip-

EXIGENCES DE L'ENTRETIEN DE L'IIMS.....DANS L'ENVIRONNEMENT RMM

INTRODUCTION

L'objet de cette section est de décrire les exigences de l'entretien associées avec l'introduction de l'automatisation pour l'acquisition de données opérationnelles et pour étendre le télécontrôle, la télécommande et l'évaluation des diagnostics à l'entretien des systèmes ou équipements électroniques et électriques.

OBJECTIFS DU TÉLÉCONTRÔLE DE L'ENTRETIEN (RMM)

Les objectifs de l'IIMS sont:

- Réduire le coût de l'entretien;
- Augmenter l'efficacité et le rendement de l'entretien.

RMM atteindra ces objectifs en:

- Réduisant le nombre des visites aux emplacements;
- Permettant une meilleure centralisation du personnel;
- Facilitant l'accès aux registres, à l'historique de l'équipement et, au besoin, à l'aide technique;
- Simplifiant les procédures de certification des systèmes ou de l'équipement;
- Augmentant le temps de disponibilité des systèmes;
- Réduisant la paperasserie par le biais de l'automatisation.

CONTRAINTES

Les exigences du système ou de l'équipement principal telles que l'intégrité, la fiabilité et la sécurité sont des facteurs d'une influence primordiale dans la réalisation des objectifs du RMM. Ces exigences relatives au système ou à

ment requirements shall take precedence.

l'équipement principal ont priorité dans le cas où les objectifs du RMM ne peuvent être atteints sans les compromettre.

MAINTENANCE CENTRE CONCEPT.....
Application of "MAINTENANCE 2000"

In the "Maintenance 2000" environment, the maintenance workforce will be concentrated in Maintenance Centres responsible for the maintenance of electronics systems/equipment in a defined geographic area. They will perform the majority of their duties from the Maintenance Centre using the RMM as their principle tool and test instrument. Critical parameters will be monitored electronically and fed to the Maintenance Centre. If a fault occurs, qualified personnel will carry out remote diagnostics and systems analysis, isolating the problem to the Lowest Replaceable Module (LRM). The RMM will be tailored for easy and efficient access by its users and will interface with each ANS system and non-ANS system as required.

CONCEPT DU CENTRE D'ENTRETIEN.....
Application de "ENTRETIEN 2000"

Dans l'environnement "ENTRETIEN 2000", le personnel d'entretien sera concentré dans des centres d'entretien chargés de l'entretien des systèmes et des équipements électroniques installés dans une zone géographique définie. La majorité des tâches du personnel d'entretien sera effectuée à partir du Centre d'entretien en utilisant le RMM comme outil principal et comme instrument de mesure. Les paramètres critiques seront contrôlés électroniquement et transmis au Centre d'entretien. En cas de panne, un personnel qualifié exécutera un télédiagnostic et une télé-analyse du système, isolant ainsi la faute au plus petit module remplaçable (LRM). Le RMM sera conçu pour permettre, suivant le besoin, une interface avec chaque ANS (système d'aide à la navigation) et à ses utilisateurs un accès facile et efficace.

A processing system will allow the functions/capabilities required at the Maintenance Centres, Work Centres, host system/equipment sites, and other authorized locations to be carried out. Access to the system by authorized personnel will be via a physical unit referred to as a maintenance terminal. This terminal will be capable of communicating with and taking control of all systems and equipment that are associated with remote maintenance monitoring. These terminals will alert personnel to alarm conditions and permit the exchange of information associated with monitoring and control. Terminals with similar capabilities will be used to access the RMM from

Un système de traitement accordera l'exécution des fonctions ou capacités nécessaires aux centres d'entretien, centres de travail, emplacements des systèmes ou des équipements principaux et autres endroits autorisés. Le personnel autorisé aura accès au système par l'intermédiaire d'un périphérique appelé terminal d'entretien. Ce terminal d'entretien sera capable de communiquer avec tous les systèmes et équipements associés avec le télécontrôle de l'entretien et de les prendre en charge. Ces terminaux avertiront le personnel des alarmes et permettront l'échange d'information concernant les commandes et le contrôle. Des terminaux ayant des capacités semblables seront

Introduction

S/3 SCADA SYSTEM DESCRIPTION

INTRODUCTION

What distinguishes the S/3 product in the marketplace is its unique distribution of functionality among the configuration components. The S/3 SCADA Host, the S/3 Color Consoles, the S/3 Workstations, the Communications Concentrator Modules, and the S/3 RTUs each contribute intelligent control to their realtime tasks.

The SCADA S/3 Host is a VAX-based computer whose major functions are to maintain the realtime database (no buffered data in the system), run S/3 tracking and archiving packages, and execute supervisory programs and alarm typers.

The realtime database is updated by realtime tracking tasks:

- The alarm tracking task stores analog and digital alarm messages. These messages specify the time of alarm, source RTU, point value or state at alarm time, engineering units, and alarm type.
- The operator/supervisor action tasks record point value changes and other actions made from S/3 consoles. Operator consoles can be configured for access to all system data and displays or for access to selected system data and displays.
- The system status stores status messages sent from the RTUs, CCMs, and backup Host. These messages indicate the operational condition of RTUs, CCMs, and Host components, such as I/O boards and communication channels.

The realtime database information is available for printing through the Report Generator subsystem, part of the Application Programming Environment (APE). Through this package, you define report formats, functions and calculations, so as to extract and manipulate data according to your specific needs.

The S/3 Color Console and the S/3 Workstation operate as the on-line window into the realtime database, as well as being the Man-Machine Interface to the realtime SCADA functions. Each of the color consoles is a powerful independent display computer which encompasses the tasks of display generation and graphics creation. Specifically, each console unit includes a 19" CRT, a 32-bit microcomputer, a video generator board, and a Winchester disk drive. Depending on the specific console operational objective, the multi-function keyboard is either dedicated to one console unit or shared by up to eight console units. Additional console selection devices include an annunciator panel, a trackball, a touchscreen, digitizer pad and pen, and a mouse.

All screen display formats are stored locally in the S/3 Color Console (or S/3 Workstation) and only data is fed from the Host computer. Once a display is called to the screen, only changed values of realtime data are forwarded from the Host. This local display generator and refresh capability minimizes overhead in the Host to support complex on-line console operations.

The Communications Concentrator Module (CCM) further reduces Host overhead. The CCM is a microcomputer which polls the RTUs. The "foreign" interface board allows the CCM to poll protocols other than that of the S/3 RTU. This gives you the flexibility to configure the field as required. A "translation database" is established in the CCM which is used to "map" values (from foreign RTUs) into the Host databases. This means that all Host-based SCADA functions and reporting facilities remain the same for all database information, because it is all in the same format.

The S/3 RTU can be configured to perform intelligent functions which are programmed through the INTERLOCK sequential control language and high level language programs. This is important where line delays add an unacceptable factor to time-dependent or critical functions.

The S/3 SCADA System is uniquely designed with intelligence in four key functional areas: the Host, the man-machine interface, the communications concentrator, and the RTU. By so distributing the tasks, the Host is offloaded of many CPU-demanding functions. This reduces the possibility of a CPU bottleneck, improves overall efficiency of the SCADA system, provides for multiple layers of redundancy, and allows greater flexibility of configuration and growth.

S/3 System Architecture

GENERAL

The S/3 SCADA System provides console operators and other personnel the capability to monitor and control network operations in real–time. The S/3 System is functionally divided into three major areas of responsibility:

1. Acquisition of device status and data from field devices at remote sites.
2. Processing of the data required to monitor operations and presenting the data to console operators in a timely manner.
3. Transmitting console operator–initiated control commands to the remote sites for device controlling.

Instant network visibility is provided by the man-machine subsystem utilizing color graphic consoles. Field device status is transmitted, and calculated data quantities are updated at the consoles continuously. The system continuously monitors remote site data for system errors, communication errors, uncommanded field device changes, limit violations and rate-of-change, while the alarm and event subsystem immediately notifies the dispatchers via audible tone and blinking visual display. Alarms and logs are chronologically recorded automatically and by demand on printers for historical purposes. System trending and archiving capabilities are also provided.

The S/3 SCADA system can include S/3 redundant Hosts with supporting peripherals, color consoles or workstations, communications concentrator modules, and interfaces to provide a fully integrated distributed SCADA system.

SYSTEM PURPOSE

The primary purpose of the S/3 SCADA system is to gather and process information in real-time. The system provides major contributions today and for future operations requirements. The system enables the user to retrieve, display and archive required network information to more efficiently operate and control the designated process.

SYSTEM ARCHITECTURE

The S/3 SCADA system is an integrated, state-of-the-art, computer-based supervisory control and information system provided in a redundant configuration.

The failover subsystem, consisting of hardware and software, provides backup computer system security in the event of a primary computer system failure. A failover is defined as the events that take place when the backup system acquires the role of primary due to a primary system failure. A failover is automatically initiated by the backup when it detects that the primary system has failed. A failover may also be initiated manually by the system operator or maintenance personnel by shutting down the primary system. The system is designed so that either CPU with its dedicated peripherals may operate as either primary or backup Host. Operational data transfers from one system to the other take place via the ETHERNET and DECnet interfaces. Field-acquired data (pressures, temperatures, flows, etc.) is also transferred from one system to the other via the ETHERNET and DECnet interface. System console data (orifice factor changes, etc.) is transferred in the same manner.

The following events take place during a system failover:

- Primary system fails.
- Peripheral switch changes assignment of shared peripherals.
- Backup system notices both events.
- Backup system prints a message on a hard copy device to indicate that it is assuming the primary role.
- Backup system assumes the primary role.

SYSTEM HARDWARE DESCRIPTION

The hardware provided for the SCADA System includes equipment manufactured by both Texas Instruments and Digital Equipment Corporation (DEC). A description of each major component follows:

S/3 COLOR CONSOLE

The S/3 Color Console is a complete microcomputer system. The console provides:

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The Year in Review

Secure Voice Communications

We announced, during the past year, the award of three production contracts for our Shipboard Integrated Interior Communications (SHINCOM) system. Together, these contracts ensure that our system will be on all of the principal warships in the Canadian Navy.

Specifically, the contracts call for the supply of dual systems for:

- the six Canadian Patrol Frigates (CPF) now under construction,
- the four destroyers that are being upgraded as part of the Tribal Class Update and Modernization Program (TRUMP),

and single equipments for:

- the Radio Remote Secure Voice Systems (REMSEVS) that will be retrofitted to thirteen existing Canadian warships.

SHINCOM is a sophisticated and secure militarized telephone exchange. It enables communication within the warship and access to the external environment. Using all digital switching technology, it provides the security, speed, reliability and survivability of voice communications that are so essential to the operation of a modern warship.

This system is one of the most advanced of its type in the world. It breaks new ground in that all voice communications on board the ship are integrated into one system. This eliminates the proliferation of intercommunication equipments on existing ships. Furthermore, the system provides ease of operation, combined with significant savings in weight, space and installed costs.

For the CPF and TRUMP programs, the SHINCOM configuration comprises duplicated central switches to provide high availability and reliability. The two switches are physically separated within the ship, in order to increase survivability in the event of battle damage. The SHINCOM system is capable of providing in excess of 400 lines of communication, although the ships in these two programs will use approximately half that capacity. The system is accessed through three levels of terminal complexity.

The REMSEVS configuration has a more compact 96 line single switch, which is used to control access to the external secure radio networks on board the ship, through two types of terminals. The system is part of the Secure Voice and Teletype Project, which will provide existing destroyers with more secure communications.

During the year, the Company pursued new markets and new applications for the system. We are investing in the future by adapting the product to meet a much wider range of warship needs, including those of submarines and light frigates.

Outside of the naval environment, the Company has embarked upon initial development of system derivatives for tactical land-based and airborne usage. To this end, system enhancements are being incorporated that will greatly increase the modularity and flexibility of the system. In addition, system software will be converted to the Ada programming language in response to contemporary trends in the defence markets.

Our SHINCOM integrated communications system will be installed in all major Canadian warships, including the four Tribal class destroyers currently undergoing modernization. Shown above right is the central switch of the SHINCOM system.

The Year in Review

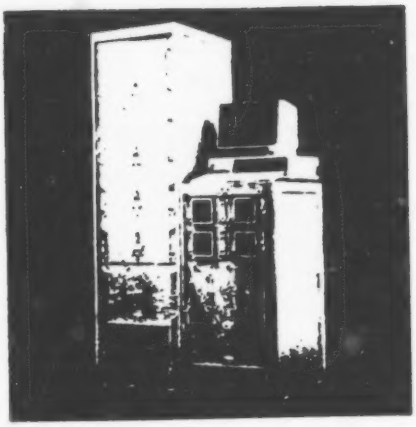
Navigation Systems

Our Tactical Air Navigation (TACAN) beacon system provides navigation data to en-route or terminal aircraft that are within a 250 nautical mile range of the beacon. The TACAN system responds to an interrogation signal from any suitably equipped aircraft. It sends back information from which the aircraft calculates its range and bearing with respect to the beacon. We offer our TACAN in land-based, shipborne and mobile variants.

During the past year, we have achieved several milestones in regard to our TACAN programs.

Substantial progress was made towards the supply of 60 land-based, dual solid state TACAN systems for the Canadian Forces. The equipment is now entering the early production stage. These systems will replace military navigation aids at widely dispersed sites across Canada. Development work to provide the system with a radio frequency output of 5 Kilowatts (Kw) is complete. The full system, both transmitter and receiver, was demonstrated to the customer in July 1987. Delivery of the equipment begins late this calendar year for program completion in mid-1989.

We have won our first export order for the solid state TACAN system. The contract from the Royal Norwegian Air Force is for twelve dual 3 Kw systems with comprehensive remote maintenance monitoring capabilities, identical to those provided for the Canadian order.



The Norwegian sale includes initial spares and a full training package, plus an option for five more systems at a later date. Production has begun and the first system will be delivered in the Fall of 1987.

The first TACAN equipment for the Canadian Patrol Frigate program was delivered earlier this calendar year, following a successful factory acceptance test. This system has now been installed in the customer's Montreal test facility, as part of the combat system simulation for the new frigate. We anticipate spares orders for this program as well as a further TACAN order for the second series of Patrol Frigates.

Other engineering work has involved adapting our TACAN system to interface with the full range of available antennas. These improvements increase the range of export prospects for which we can bid.

In addition, we have begun development of a TACAN-related derivative known as Distance Measuring Equipment (DME). As the name implies, DME provides an interrogating aircraft with its distance from a fixed base. This project is aimed at upcoming domestic requirements for Transport Canada, as well as specific export opportunities.

Real-time Photogrammetry

This equipment forms the major part of the Space Vision System, which will aid operation of the remote manipulator arm on the space shuttle. The flight hardware, already delivered to the National Research Council, was in laboratory use last year for experimental testing. The system is expected to make its space debut with the Canadian Astronaut Mission program in late 1988, after the renewal of space shuttle flights.

The Real-time Photogrammetry System views, tracks and determines the position of objects in three-dimensional space through pattern recognition. As the name implies, the photogrammetric calculations are performed in real time as the object moves. The system enables an operator to follow quickly those movements, thereby capturing and handling the object with greater speed and efficiency.

Engineering development in the coming year will add computing power to automate the system and reduce the need for operator intervention.

Potential uses continue to emerge for this technology in a number of difficult environments. Our laboratory demonstrator permits an initial evaluation of the system's capability and flexibility in some of these new roles. Such opportunities include the recovery of remotely piloted vehicles, assistance to helicopter landing on ships and the monitoring of thermal distortion in large space-based structures.

The F-16 seen here is part of the fleet flown by the Royal Norwegian Air Force which will depend on our TACAN system for vital navigational data during their NATO missions. Incorporating a full remote maintenance monitoring system, the TACAN beacon, pictured above, delivers accuracy and reliability while minimizing human error.

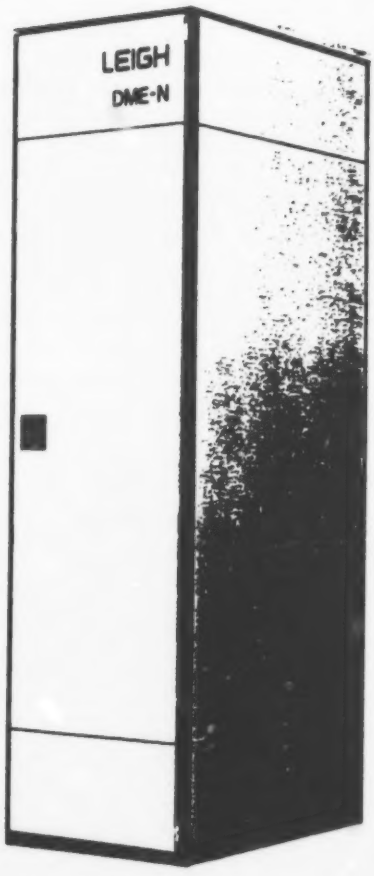
DME FOR THE NINETIES

Distance Measuring Equipment (DME) beacons are vital navigation elements in today's air traffic control system.

To meet the demands of the nineties and beyond, Leigh has developed and is now flight testing an advanced technology DME which offers superior performance, high reliability and low cost of ownership.

Leigh has an enviable track record in DME. Its military Tactical Air Navigation

(TACAN) - which incorporates a civil DME - has been chosen for use by Transport Canada, the Department of National Defence, the Royal Norwegian Air Force and the People's Republic of China. Leigh's TACAN is an important winner of export revenue.



Our new civil DME builds on this reputation. Designed to meet Transport Canada's future specifications, it offers innovative features and operational flexibility. For example, its DME/N (en-route) mode can be easily converted to the very high accuracy DME/P (precision) mode for use with Microwave Landing Systems (MLS).

Leigh's DME and the MLS built by Micronav - Leigh's Cape Breton subsidiary - will be a winning combination in the world air traffic control marketplace of the nineties.

LEIGH

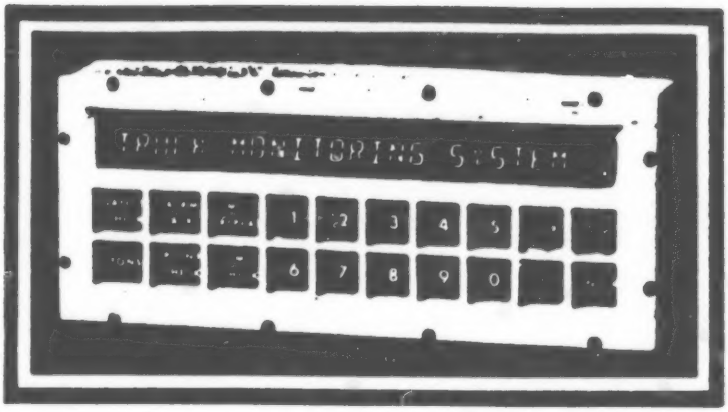
260 Hearst Way, Kanata, Ontario K2L 3H1
Telephone: 613-591-3220
Telefax: 613-591-0945

APPENDIX - V: Mobile Equipment Monitoring System of AES

ADVANCED ELECTRONIC SYSTEMS LTD.

SMART OPERATOR™

HEAVY EQUIPMENT MONITORING



- INCREASE AVAILABILITY
- MEASURE PRODUCTIVITY
- DECREASE MAINTENANCE COSTS
- UTILIZE PREDICTIVE MAINTENANCE

The most advanced and comprehensive system available to protect your equipment investment and increase production.

FEATURES —

- PREDICTIVE protection
- Real-Time protection
- Equipment Health and Diagnostics
- Fleet-wide Polling
- Automatic Data Collection
- Automatic Data Analysis

VEHICLE SYSTEMS MONITORED & PROTECTED —

- Engine
- Hydraulics
- Electrics
- Transmission
- Torque Converter
- Load Weighing

ADVANCED ELECTRONIC SYSTEMS LTD. 30 Concession Drive • Suite 111 • Unionville • Ontario • Canada • L3R 6B8 • (416) 479-5757

SYSTEM DESCRIPTION

A comprehensive monitoring and diagnostic system designed to increase the availability and productivity of heavy diese /electric machinery

The on-board equipment monitors, stores, analyses, and automatically transmits equipment health and trend data to a base station for productivity and maintenance reporting.

* ON-BOARD COMPUTER

Consists of an Operators Display and a Sensor Interface Unit (SIU). The vehicle computer is a rugged and reliable system that gathers health and diagnostic data from the vehicle systems, analyses the data and provides both real-time and predictive information.

Production Monitoring & Load Weighing provides the operator and management with unit and fleet production totals.

* COMMUNICATIONS

Built in communications transfers data from the equipment to the base station. Options include: internal FM transmitter and receiver, internal modem for external radio, infrared transceiver, and removable data cartridge.

* BASE STATION

An IBM ™ PC with our diagnostic and production reporting software polls a fleet of equipment to obtain operating and maintenance data.

Vehicle configurations (setpoints, alarms etc.) are created in the base and automatically downloaded to the remote equipment via radio.

SPECIFICATIONS

Power: 12 or (24) VDC
4 or (2) Amperes

Memory: 96K (200K with cartridge)

Environmental

Temperature: -40 to +65 Deg. C.
Humidity: 10 to 100%
Vibration: Mil 810C

Inputs

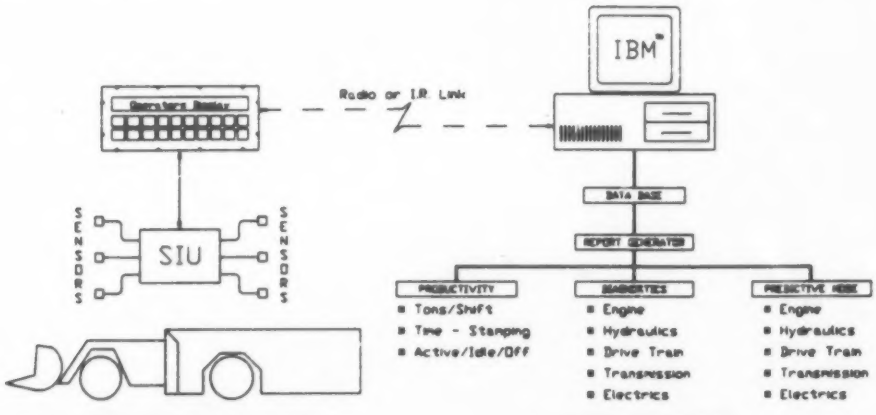
Analog: 80
Pulse: 8
Digital: 24

Communications

RS 485 LAN Port — FM RF Port
RS 232C Port — RF Modem Port
Bell 212 Modem Port — Infrared Port

Display 24 character, alpha numeric LED type, scrolling

Keypad Sealed Membrane Switch
10 numeric keys
6 programmable special function
4 data entry/edit



ON-BOARD EQUIPMENT **BASE STATION**

FOR FURTHER INFORMATION CONTACT:

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